Development and Feasibility of a Swimming Programme as a Rehabilitation Modality for People with Chronic Low back Pain: A Mixed Methods Project

by

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Abstract

Chronic low back pain (CLBP) is a complex multidimensional condition impacting physical activity, function, quality of life and health. It is common practice for health professionals to recommend swimming to people with CLBP for rehabilitation and to improve levels of physical activity. There are several key uncertainties and limited research supporting this recommendation and a lack of specific swimming frameworks this population. The aim of this project was to develop and explore the feasibility of a swimming programme as a rehabilitation modality for people with CLBP.

A mixed methods multi-phase project was designed within the research paradigm of pragmatism, to develop a swimming programme. Collectively the programme objectives enabled swimming to be delivered as a CLBP rehabilitation modality, not simply as instructional swimming sessions. Exploratory research was conducted to understand determinants impacting uptake and engagement and the experience of people swimming with CLBP. The findings were combined with further data in a modified Delphi study involving all stakeholders, leading to the development of the swimming programme. All aspects of the programme were considered, including the setup, pre-programme information, delivery, teaching approaches, session brief, warmup, cooldown, core aquatic skills, swimming strokes and strategies to enable regular swimming. The final study evaluated the feasibility of the swimming programme as a rehabilitation modality and the trial procedures. Meta inferences were drawn from the collective data involving all four studies to enable the swimming programme to be refined for future research.

The findings indicated that a swimming programme, teaching swimming and pain management skills is a feasible and safe rehabilitation modality for people with CLBP, enabling physiotherapists and swimming professionals to collaboratively deliver rehabilitation and education in the community. The programme will undergo further development; well-designed randomised clinical trials are required to measure outcomes, impact, and cost effectiveness, comparing the intervention to usual care.

Contents

Table of Tables

Table of Figures

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Abbreviations

APPEASE Affordability, Practicability, Effectiveness and cost effectiveness, Acceptability, Side effects / Safety and Equity.

ATACP Aquatic Therapy Association of Chartered Physiotherapists

AM Automatic Motivation

BCW Behaviour Change Wheel

BPS Biopsychosocial model

CLBP Chronic Low Back Pain

COM-B model Capability, Opportunity, Motivation, Behaviour model

CONSORT Consolidated Standards of Reporting Trials

CSP Chartered Society of Physiotherapists

DOH Department of Health

EKHUFT East Kent Hospitals University NHS Foundation Trust

FINA Federation Internationale de Natation

GP General Practitioner

HRA Health Research Authority

IQR Interquartile range

LBP Low Back Pain

LGBTQ+ Lesbian, gay, bisexual, transgender, queer / questioning

MECC Making Every Contact Count

MRC Medical Research Council

MSK Musculoskeletal

n number

NHS National Health Service

NICE National Institute for Health and Care Excellence

NIHR National Institute of Health and Care Research

ODI Oswestry low back pain Disability Index

PAR-Q Physical Activity Readiness Questionnaire

PhC Physical Capability

PIO Population Intervention Outcome

PICO Population Intervention Comparison Outcome

PICOS Population Intervention Comparison Outcome Study

PO Physical Opportunity

PPI Patient and public involvement

PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PsC Psychological Capability

PSEQ Pain Self-Efficacy Questionnaire

QUAL Qualitative

QUAN Quantitative

REF Research Excellence Framework

RoB 2 tool Risk of Bias tool

ROBINS-1 tool Risk Of Bias In Non-Randomised Studies of Intervention tool

SD Standard Deviation

SO Social Opportunity

STA Swimming Teacher Association

RCT Randomised Controlled Trial

RM Reflective Motivation

TDF Theoretical Domains Framework

UK United Kingdom

WHO World Health Organisation

y years

Chapter 1: Introduction

1.0 Introduction

The first chapter will introduce the background and rationale for the thesis, which has explored and developed a swimming programme as a rehabilitation modality for chronic low back pain (CLBP). Despite swimming being commonly advised to people with low back pain (LBP) there is limited research evidence and no guidelines to support this recommendation. The chapter will initially discuss the epidemiology and complexity of CLBP, explore the key recommendations of group exercise and self-management from the National Institute for Health and Care Excellence (NICE) guidelines for LBP and sciatica and consider how the guidelines translate into physiotherapy practice. The chapter will consider the potential benefits of swimming for people with CLBP, explore determinants impacting engagement and key uncertainties. The gaps in service provision and lack of specific swimming frameworks will be highlighted alongside the stakeholders who could be involved if swimming was provided as a rehabilitation modality. The second part of this chapter will review the following theoretical frameworks; the COM-B model and Behavioural Change Wheel (BCW), the Swim England, and Swimming Teacher Association (STA) adult learn to swim frameworks and the Medical Research Council (MRC) framework. The chapter will explain how these frameworks will be used in this thesis to develop a theoretical understanding of swimming as a rehabilitation modality and guide the research design, aims and objectives. The chapter concludes by introducing the project aim, objectives, and thesis structure.

1.1 Background

1.1.1 Back Pain Epidemiology

Activity limiting LBP is very common; LBP has been found to account for 14% of General Practitioner (GP) musculoskeletal consultations in the United Kingdom (UK) (Jordan et al. 2010). The 2021 Global Burden of Disease Study reported that LBP is the leading cause of disability, affecting 619 million people globally and projected to increase to 843 million by 2050 (Ferreira et al. 2023). LBP is not a disease but a symptom (Hartvigsen et al. 2018); it refers to pain the lumbar or sacral regions (ICD10Data.com 2019). Most LBP is termed non-specific; meaning that no specific cause can be identified (Hartvigsen et al. 2018; Maher et al. 2017). For some people LBP is not a self-limiting condition; a systematic review of the natural course of LBP found that between 42% and 75% of people are still experiencing pain after 6 months and 44% and 78% of people experience another episode of pain (Hestbaek et al. 2003). Persistent or recurrent LBP is categorised as a chronic primary pain, which is defined as a pain that lasts more than 3 months and '*is associated with significant emotional distress or significant functional disability'* (Treede et al. 2015). The prevalence of chronic pain in the United Kingdom (UK) population is estimated to be 13% (Breivik et al. 2006). The impact of pain on physical activity, function, work, quality of life, health and the need for treatment varies within the LBP population. A systematic review and meta-analysis of work absence and return to work in people with LBP found that approximately a fifth of workers with LBP have a period of work absence of six months or longer (Wynne-Jones et al. 2014). Furthermore, a survey found that 6% of people with chronic pain were no longer able to and 24% were less able to manage an independent lifestyle; two thirds of people with chronic pain were receiving pain treatment (Breivik et al. 2006).

There are factors which may increase the risk of developing CLBP and co-morbidities which may evolve in people with LBP. Risk factors include being in a lower socioeconomic group (NHS Digital, 2018), lower educational attainment (Dionne et al. 2001, Schmidt et al. 2007), undertaking manual work (Hoogendoorn et al. 1999), increasing age (Ferreira et al. 2023; Leclerc et al. 2009), being female, (Leclerc et al. 2009), smoking (Ferreira et al. 2013; Green et al., 2018; Schmelzer et al. 2016), being overweight or obese (Elgaeva et al. 2020; Frilander et al. 2015; Green et al. 2018; McVinnie 2013; Okifuji and Hare 2015; Suri et al. 2017), having

type 2 diabetes (Pai et al. 2015; Pozzobon et al. 2019), stress (Schmelzer et al. 2016), having poor general health (Parreira et al. 2018) and reduced levels of physical activity (Shiri and Falah-Hassani, 2017; Ferreira et al. 2013). Some of these risk factors, such as smoking and physical activity are modifiable risk factors which could be targeted by health care interventions. People with CLBP are more likely to suffer from obesity (Janke and Kozak 2012), depression (Hagen et al., 2006), degenerative joint, cardiovascular and respiratory diseases (Schneider et al. 2007; Williams et al. 2018).

1.1.2 The Flag System

The flag system is a framework for assessing physical and psychosocial risk factors in people with LBP (National Health Committee 1997; Nicholas et al. 2011), see Table 1.

Table 1: The flag system (Nicholas et al. 2011)

Flag	Nature	Examples
Red	Signs of serious spinal pathology	Cauda equina, fracture, tumour
Orange	Psychiatric symptoms	Clinical depression, personality disorder
Yellow	Beliefs, appraisals and judgements	Unhelpful beliefs about pain: indication of injury as uncontrollable or likely to worsen, expectations of poor treatment outcome, delayed return to work
	Emotional responses	Distress not meeting criteria for diagnosis of mental disorder, worry, fears, anxiety
	Pain behaviour	Avoidance of activities due to expectations of pain and possible reinjury, over-reliance on passive treatments (hot packs, cold packs, analgesics)
Blue	Perceptions about the relationship between work and health	Belief that work is too onerous and likely to cause further injury, belief that workplace supervisor and workmates are unsupportive
Black	System or contextual obstacles	Legislation restricting options for return to work, conflict with insurance staff over injury claim, overly solicitous family and health care providers, heavy work, with little opportunity to modify duties.

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Red flags refer to serious pathology causing LBP, conditions which require further investigations and medical and or surgical interventions; exercise and rehabilitation may be provided at a later stage but only when the condition is treated or in the case of fractures, healing has occurred. There are four flags which consider psychosocial factors which could

impact on CLBP management. Orange flags are serious psychiatric conditions, rehabilitation involving exercise in the presence of these conditions would need to be carried out as part of a multidisciplinary team including a psychiatrist. Yellow flags are behavioural factors impacting CLBP management such as anxiety, fear avoidance, and low self-efficacy. People with CLBP with yellow flags should be offered more than simple education and exercise, instead they should receive rehabilitation from specialist physiotherapists targeting both behavioural and physical factors (Nicholas et al. 2011). Blue flags refers to the person's work status and perception of work and black flags refers to the actual working conditions, occupational health teams may need to be involved as part of the rehabilitation plan in the presence of blue and black flags.

Screening frameworks and questionnaires can help assess for these five flags, guide when other professional input is required and help formulate a prognosis (Finucane et al. 2020; Nicholas et al. 2011; Seyfried 2018). The NICE back pain and sciatica guidelines recommend the use of the STarT back risk assessment tool in primary care to enable the right level of input to be provided to people with CLBP (NICE 2016). The STarT back questionnaire includes questions about yellow flags, including beliefs, emotional responses and pain behaviours (Traeger and McAuley 2013). Other questionnaires which also screen for yellow flags include the OSPRO-YF and the Orebro musculoskeletal pain questionnaire (Lentz et al. 2016; Linton and Boersma 2003). It has been found that using a tool such as the STarT back, can significantly reduce CLBP disability, reduce absence time from work and make better use of healthcare resources (Foster et al. 2014; Hill et al. 2011).

1.1.3 Complexity

For some with people, due to the impact of co-morbidities and psychosocial factors, CLBP can be experienced as a complex, multidimensional condition influenced by several interacting systems (O'Sullivan et al. 2016), for this reason the national guidelines recommend using the biopsychosocial (BPS) model when assessing and developing a management plan with people with CLBP (Foster et al. 2018, NICE 2016). The BPS model, depicted as a Venn diagram recognises that there are physical, psychological, and social dimensions to illness (Engel 1977). In the field of pain management, this approach moves away from the biomedical view of LBP being a spinal disease to an understanding that it is an illness which can cause disability

(Waddell and Main 1999). The three dimensions in the model are not distinct or static but overlap, interact, and vary in composition and proportion between individuals and within individuals over time as illustrated in Figure 1 (Jull 2017; Mescouto et al. 2022).

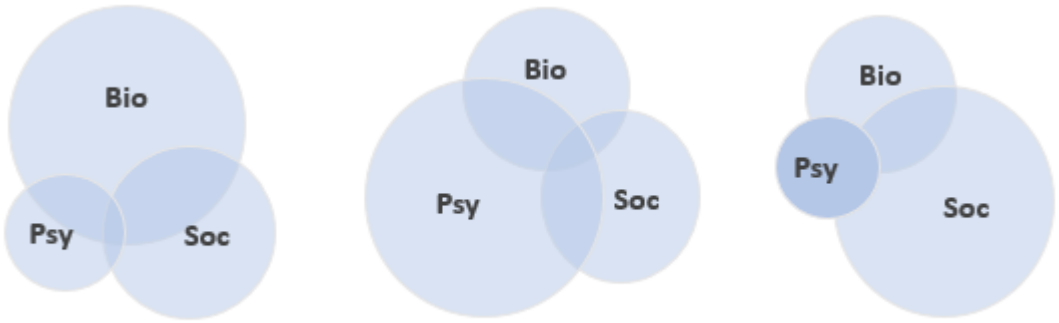

Figure 1: Biopsychosocial model (Jull 2017)

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Key: Bio: Biological; Psy: Psychological; Soc: Social

Physical factors include exposure to load, local pathology, and past medical history; psychological factors include thoughts and emotions; and social factors include influences at work and home. Factors in each dimension can be divided into modifiable factors such as lifestyle factors and non-modifiable factors such as sex, age, and genetics, to aid in the development of a management plan (O'Sullivan et al. 2016). In addition to the three dimensions in the BPS model it has also been proposed that patient therapist interaction and person valued goals can also impact CLBP and the rehabilitation journey (O'Sullivan et al. 2016). There is currently no recognised definition for categorising when a condition is more or less complex, it is acknowledged that complexity is not a binary concept, but on a continuum (Safford, Allison and Kiefe 2007). For the purpose of this project complexity refers to '*the degree of complication of a system or of a system component, determined by such factors as the number and intricacy of interfaces, the number and intricacy of conditional branches, the degree of nesting and the types of data structures*' (Nardi et al. 2007, p.362). Aligning with this definition a proportion of people with CLBP will be categorised as having a

complex multidimensional condition due to the wide range of interrelated factors influencing and impacting their condition.

1.1.4 NICE Guidelines

The NICE LBP and sciatica guidelines recommend group exercise programmes, either mind-body, aerobic or biomechanical or a combination of these approaches, as a non-invasive treatment for LBP, stating that the patient's '*specific needs, preferences and capabilities*' should be acknowledged when recommending exercise (NICE 2016). Participation in exercise and physical activity can be challenging for people with chronic pain (Vader et al. 2021). There are physical, mental, and social barriers to exercise and physical activity for people with CLBP (Vader et al. 2021) and having CLBP has been found to influence whether a person can perform an exercise (Gabel et al. 2018). Other national guidelines also recommend exercise for LBP, including the National Health Service (NHS) England National LBP pathway (NHS England 2017), the American College of Physicians guidelines (Qaseem et al. 2017) and the Danish clinical guidelines (Stochkendahl et al. 2018). The Danish guidelines highlight that exercise has a beneficial impact on patient general health and adverse effects are rare (Stochkendahl et al. 2018).

The NICE guidelines also recommend health professionals provide information and advice to enable self-management (NICE 2016). Self-management, in medical terms, can be defined as '*the tasks that individuals must undertake to live well with one or more chronic conditions*' (Adams, Greiner and Corrigans 2004). People with long-term health conditions will only spend on average 4 hours a year with a healthcare team, the rest of the time they will self-manage their condition (Self-management UK 2022). Self-management doesn't imply that people can't seek support; part of self-management is knowing what services can be accessed (Self-management UK 2022). There are numerous theories and theoretical frameworks in the field of self-management (Lawless et al. 2021); however, the common factor is that enabling self-management requires behaviour change. As part of the NHS long term plan there has been a move away from self-management to supported self-management for long-term conditions (NHS England 2020). Supported self-management aims to improve and build skills, knowledge and confidence through coaching, education, and peer support (NHS England 2020). Enabling self-management is not simply providing a recipe but also teaching problem-solving, decision-

making skills and action planning (Hutting et al. 2020). The national back pain pathway provides guidance on self-management advice, including information about the nature of LBP, staying active, coping strategies, pain management skills and accessing self-directed exercise programs (NHS England 2017).

1.1.5 Rehabilitation and Physiotherapy

People with CLBP may consult a health professional for several reasons, sometimes they are seeking a diagnosis or specific treatment and others require support in the form of rehabilitation (Kamper et al., 2018). The World Health Organization (WHO) define rehabilitation as '*a set of interventions designed to optimise function and reduce disability in individuals with health conditions in interaction with their environment*' (WHO 2021). Rehabilitation is provided for a wide range of conditions and diseases, not just LBP, however, there are common processes and interventions across conditions. Common processes include the use of the BPS model and structured protocols, a person-centred approach, and delivery by a multi-disciplinary team, with common interventions including exercise, education, and self-management (Wade 2020). Rehabilitation is a complex intervention due to many factors including multiple components, variability in quantity and intensity and an uncertain cause and effect relationship (Wade 2020). Rehabilitation targets multiple domains, and this is reflected in the outcome measures used in clinical practice and research which measure changes in pain quantity and interference, pain self-efficacy, physical and emotional function, and quality of life (British Pain Society 2019).

Physiotherapists provide specialist assessment and use exercise, advice, and information as rehabilitation modalities (Liddle, Baxter and Gracey 2009) in line with the NICE LBP and sciatica guidelines (NICE 2016). There are different forms of exercise used by physiotherapists for people with CLBP; there is no evidence that one form of exercise is superior to another for LBP (Foster et al. 2018). Usually, exercises are graded and adapted or modified for individual patients depending on assessment findings and comorbidities; exercise might be undertaken in a gym, at home or in a hydrotherapy pool (Quentin et al. 2021; Shi et al. 2018, Shipton 2018,). Exercises prescribed by physiotherapists for CLBP might aim to improve fitness, levels of physical activity, function, strength, range of movement, reduce fear of movement, manage weight, and enable people to return to work, recreation and sport (Hayden et al. 2021; Staal

et al. 2012). To encourage long term change and self-management physiotherapists may also provide information and use behavioural change techniques such as goal setting (Harman et al. 2014).

1.1.6 Aquatic Therapy, Aquatic exercise, and Swimming

Aquatic therapy is one form of exercise provided by physiotherapists to people with CLBP as a rehabilitation modality (Pires Cruz and Caeiro 2015). It has been suggested that aquatic based exercise can be more bearable than land-based exercise for people with CLBP due to the effects of buoyancy unloading the spine (Baena-Beato et al. 2013; Becker 1997; Winter et al., 2002). Aquatic therapy is defined by the Aquatic Therapy Association of Chartered Physiotherapists (ATACP) as: '*a therapy programme utilising the properties of water, designed and supervised by a suitably qualified physiotherapist specifically for an individual to improve function, ideally in a purpose built, and suitably heated hydrotherapy pool*' (ATACP, 2014). NHS patients are usually eligible for three to six sessions of aquatic therapy in a hydrotherapy pool, following discharge they are encouraged to continue practising the aquatic exercises learned during the sessions independently in a local swimming pool (EKHUFT 2022). When compared to land-based exercise the aquatic environment offers several advantages for people with CLBP due to the physical properties of water, including movement being easier when changing position (Brody and Geigle 2009). There is evidence that aquatic therapy and aquatic exercise can be helpful in the short-term management of LBP (Shi et al. 2018) but there are barriers to long term adherence (Hornsby 2016). It is not known what proportion of people with CLBP continue to practice the aquatic exercises learned during aquatic therapy sessions after discharge.

It is also common practice for health professionals to recommend swimming to people with CLBP for rehabilitation, pain management and to improve levels of physical activity (Cole et al. 1997; Ribaud et al. 2013). Swimming has been defined as the '*propulsion of the body through water by combined arm and leg motions and the natural flotation of the body*' (Britannica 2023). Swimming is similar to aquatic therapy and aquatic exercise in that it is practiced in an aquatic environment, is low impact due to buoyancy, is easy to adapt and can be used as a form of muscular training (Dunlap 2009; Laughlin and Delves, 2004; Poyhonen et al. 2002). Swimming, however, has several differences which could offer additional practical

and therapeutic benefits when used as a rehabilitation modality with people with CLBP. Table 2 outlines the key differences between aquatic therapy, aquatic exercise, and swimming.

Table 2: Key differences between aquatic therapy, aquatic exercise, and swimming

	Aquatic Therapy	**Aquatic exercise**	**Swimming**
Scientific principles	Utilises the physical and fluid dynamic properties of water to aid rehabilitation.	Utilises the physical and fluid dynamic properties of water to improve and maintain muscle strength, endurance, and fitness	Utilises buoyancy, maximising propulsion whilst minimising drag to enable the person to move through the water.
Delivery	Delivered by a physiotherapist trained in aquatic therapy.	Can be practised independently or delivered by an aquatic instructor.	Can be practised independently or delivered by a swimming teacher or coach.
Location	Practised in a purpose-built heated hydrotherapy pool or in a regular swimming pool.	Practised in a swimming pool.	Practised in a swimming pool or in an outdoor location for example lake, sea, or river.
Skill	Users require no prior skills as fully supervised whilst in the water by an aquatic physiotherapist.	Some core aquatic skills required to enable to move safely in the water, for example ability to change direction.	Requires all core aquatic skills including floating and breathing control and swimming skills.
Purpose	Used as a rehabilitation modality to improve function, range of movement, and strengthen muscles.	Used as a form of exercise to improve and maintain muscle strength, endurance, and fitness.	Used for recreation, as a form of exercise or for competition, to improve and maintain muscle strength, endurance, and fitness.

(ATACP 2014; ATACP 2021; Dunlap 2009; Swimming.org 2023; Tsui 2020; Wei, Mark, and Hutchison 2015)

1.1.7 Benefits and Uncertainties when Recommending Swimming

From a practical point of view, unlike aquatic therapy which requires a specialist heated pool, swimming and aquatic exercise can be carried out in a community swimming pool and swimming can also be practised in open water (ATACP 2014; Payne 2018). The benefits of swimming reported in the scientific literature, swimming manuals and biographical literature are wide ranging and encompass all three dimensions of the BPS model. From a physical perspective swimming has been found to offer cardiovascular training and could be used to target some of the comorbidities associated with CLBP such as obesity, cardiovascular disease, and diabetes (Asa et al. 2012; Connolly et al. 2016; Cox et al. 2010; Lahart and Metsiois 2018; Laughlin and Delves, 2004; Nualnim et al. 2012; Tanaka 2009). It has been suggested by aquatic therapy professionals that swimming could have emotional and social benefits due to the freedom of movement experienced in the water which could translate to

improved confidence to manage CLBP (Lepore, Gayle and Stevens 2007). Furthermore, people with CLBP who struggle with land-based exercise such as walking or cycling may find an improvement in morale and wellbeing when swimming, as swimming is viewed as a normal recreational exercise or sport and not rehabilitation (Dunlap 2009).

Admittedly when compared to providing aquatic therapy or aquatic exercise there are considerations which could pose barriers including the recognition that swimming requires the acquisition of swimming skills; the swimmer must learn how to propel the body through water, control their breath and float in a supine or prone position (Maglischo 1993). Furthermore, due to limited research there are several key uncertainties impacting the variability in the advice people receive from health and swimming professionals about swimming with CLBP (Pocovi et al. 2022).

Uncertainties include whether any risks would be encountered when swimming with CLBP, which strokes to swim, whether strokes should be adapted and how often or how long to swim. There are four main swimming strokes, front crawl, backstroke, breaststroke, and butterfly; it is not known which strokes or combinations of strokes might be beneficial for someone with CLBP and whether certain strokes should be avoided (Ribaud et al. 2013). Moreover, it is not known how the action of swimming the different strokes could impact the spine and back pain. People are often advised to avoid breaststroke if they have LBP (Hofling et al. 2002; Liyanage, 2020, Young, 2016) but this could be a barrier to the average leisure swimmer with CLBP who might only be able to swim breaststroke. There is also variability in the way that people swim the strokes, based upon when and how they learned to swim, swimming competency, individual anthropometrics, strength, and range of movement (Coleman, Persyn, and Winters 2000; Newsome and Young 2012). Furthermore, the fluid dynamics of drag and thrust in swimming are complex, impacting on swimmers in different ways (Wei, Mark, and Hutchison 2015). For this reason, one person with CLBP might find swimming front crawl helpful whereas another, using a different technique, could find this stroke aggravates their pain.

It is recognised that although swimming could be used as a rehabilitation modality for CLBP, due to the variety of ways that swimming can be delivered and practice it could also exacerbate CLBP (Cole et al. 1997). The Chartered Society of Physiotherapists (CSP) advise

that physiotherapists have a duty of care to their patients to advise and provide evidence-based treatments, to consider not just the benefits but also whether there is any evidence that interventions could be harmful; this includes recommendation of exercise (CSP 2022). A recent systematic review and meta-analysis identified fourteen randomised trials evaluating the impact of aquatic therapy and exercise for LBP (Heidari, Mohammad Rahimi and Aminzadeh 2023), in contrast a systematic review investigating the effectiveness of walking cycling and swimming for people with LBP found only one randomised trial which included swimming, confirming that there is a scarcity of high-level research in this field (Pocovi et al. 2022). The scoping review found in chapter two will explore the current evidence base supporting the recommendation of swimming in more depth.

1.1.8 Swimming Uptake and Engagement

There is also limited research exploring the uptake and use of swimming people with CLBP (Baptistia, Abrantes and Atalaia, 2020; Setchell et al. 2019). When compared to land-based exercise it is recognised that exercising in water is a bigger commitment; uptake and engagement in swimming will be impacted by barriers, enablers, and preferences (Brody and Geigle 2009). A secondary data analysis of the Sport England Active Lives survey from 2017-18 found that only 1.4% of people with chronic pain had swum in the last 12 months when compared to 31.3% of the adult population (Oakes et al. 2020; Swim England 2019a). This data suggests that people with chronic pain and disability, may face additional barriers to swimming to the general population; these factors should also be considered when recommending swimming (NICE 2013; STA 2021; Thompson et al. 2020; van Stralen et al. 2009). A survey by the STA exploring inclusion in swimming reported that 45% of participants felt that people in low socio-economic groups, some religious and ethnically diverse groups and people with a disability may be excluded from swimming (STA 2021).

Research has found that people with chronic pain face a wide range of barriers when engaging with exercise (Vader et al. 2021) and additional barriers when undertaking aquatic exercise (Fisken et al. 2016). Barriers to exercise include lack of motivation, fatigue, pain, impact of comorbidities, beliefs about physical activity and perceived risk, competing demands, access to support, fear of movement, lack of time, cost and incorrect advice from a health professional or family (Boutevillain et al. 2017; Joelsson et al. 2017; McPhail et al. 2014; Vader

et al. 2021). Service provision, colder water temperature, transport, reaction to pool water, inappropriate class or instructor for their condition or age, the lack of age specific sessions and only being able to swim one stroke are additional barriers encountered when people with long-term conditions such as CLBP use aquatic exercise (Boutevillain et al. 2017; Fisken et al. 2016; Hornsby 2016). Enablers are determinants which can have a positive impact on the initiation and maintenance of exercise. Research has found that exercising under direct supervision of a health care professional, regular follow up, improved pain management, functional improvements, mental health and well-being, group exercise, and social participation are enablers to exercise and physical activity (Boutevillain et al. 2017; Joelsson et al. 2017; McPhail et al. 2014; Vader et al. 2021). The social benefits of group classes, being able to do more in the water and the positive impact on general health have been found to be enablers to aquatic based exercise (Fisken et al. 2016; Hornsby 2016).

The NICE back pain and sciatica guidelines recommend that preferences should also be considered when recommending exercise to this population (NICE 2016). Swimming preferences could include location, time of day, and type of session; it is assumed that if these factors are not recognised then this could present additional barriers. Healthcare professionals can only address some determinants impacting uptake and engagement in swimming. Swimming pools are based in the community, not hospitals therefore other stakeholders, including swimming professionals, pool operators, commissioners, local government, and the national swimming bodies also have an impact. To date, no research has been undertaken exploring the barriers, enablers and preferences impacting swimming uptake and engagement in the CLBP population. A better understanding of these factors by all stakeholders could improve the prescription of swimming and service provision for this population.

1.1.9 Service Provision

Service provision refers to the provision and delivery of a service; and considers resources such as the facilities and stakeholders (Michie, Atkins and West 2014). In contrast to aquatic therapy, swimming is commonly practised in community pools, not a hydrotherapy pool in a hospital; hydrotherapy pools are usually too small and warm to use for swimming (Swim England 2017b). The model for delivering aquatic therapy to people with CLBP is generally

based upon the therapeutic model, whereas delivery and practice of swimming is based upon the educational and recreational model (Becker and Cole 1997; Lepore, Gayle and Stevens, 2007.) It was proposed forty years ago that dividing the delivery of aquatic based activities into therapeutic, recreational, and educational approaches did not meet the needs of children with disabilities (Dulcy 1983). It was suggested that using this uni-disciplinary model could result in safety issues in the educational and recreational sector and motivational issues in the therapeutic sector which could translate to lower rates of adherence. (Dulcy 1983; Lepore, Gayle and Stevens, 2007). It could be suggested that this division in the delivery of exercise in an aquatic environment still exists in 2023 and that it also applies to adults with CLBP, impacting safety and long-term engagement in aquatic exercise and swimming. For these reasons if swimming was delivered as a CLBP rehabilitation modality a multidisciplinary collaborative approach between health and swimming professionals, should be considered to improve uptake and delivery.

There is little crossover between hydrotherapy services and community pools (Becker and Cole 1997), however health professionals can refer people with CLBP to exercise referral schemes in the community for Phase 3 and Phase 4 rehabilitation activities. Phase 3 is usually after discharge from hospital and will consist of education, exercise training, and psychological support and Phase 4 aims to help people maintain levels of physical activity (NICE 2014). People with CLBP are not referred in the earlier stages of rehabilitation, as it would be outside the scope of practice for Level 4 exercise instructors. It has been identified that one in three adults in England cannot swim 25 metres (Swim England 2019b); in contrast to other forms of exercise recommended to people with CLBP, such as walking or cycling, it is acknowledged that swimming is a more complex skill to learn and master (Laughlin and Delves 2004). Furthermore, there is evidence to suggest that swimming stroke defects, causing a secondary effect on the body will impact the movement and position of the spine during swimming, supporting the need for people with CLBP to develop a more proficient swimming technique (Cole et al. 1997). Most exercise referral schemes include access to a swimming pool and aquatic exercise but do not include swimming lessons (Folkestone Sport Centre 2022; Stour centre 2022; Tilman 2022) therefore access to pools through the exercise referral scheme may only enable more able and proficient swimmers to use swimming to manage CLBP.

Physiotherapists are trained in delivering aquatic therapy to people with complex conditions such as CLBP, but they are not trained to teach swimming unless they have additional qualifications (ATACP 2022), and swimming professionals are trained to teach and coach swimming but may not have the skills and knowledge to teach people with complex conditions unless they have undergone additional training (Swim England 2023a; Swim England 2023b). There has been a move towards greater collaboration between health and exercise professionals in order to tackle lifestyle factors which if modified can improve health outcomes for long-term conditions (Husk et al. 2019; NICE 2014; Pedersen and Saltin 2015; Shore et al. 2021). A partnership between physiotherapists and swimming professionals in a community setting could provide the best mix of expertise to deliver swimming to people with CLBP.

There are several adult learn-to-swim frameworks, the most common ones used in England were developed by Swim England and the STA following consultation with swimming professionals and experts in the industry (STA 2023, Swim England 2023c). These frameworks comprise of progressive stages; enabling swimmers to develop water confidence, aquatic skills, swimming strokes, and technique (STA 2023, Swim England 2023c). There are also numerous manuals which aim to teach adults to swim and develop swimming technique (Laughlin and Delves 2004, Liyanage 2020, Newsome and Young 2012, Shaw 2006, Smith 2014, Young 2016). Despite the widespread use, the learn-to-swim frameworks and manuals have not been evaluated using research methods. To date swimming research has focused on water safety (Stallman, Junge and Blixt 2008), improving performance in competition (Riewald and Rodeo 2015) and exploring the benefits of swimming for general health (Lahart and Metsios 2018). It is recognised that the experts who have developed these frameworks and manuals have a wide range of swimming backgrounds, ranging from competitive swimmers and triathletes (Laughlin and Delves 2004; Newsome and Young 2012) to swimming teachers with a non-competitive background (Liyanage 2020); these experiences and world views will impact on the approach they recommend. It is not known which frameworks and methods are most effective and efficient at teaching and developing swimming and whether some methods are better for certain populations, such as people with CLBP.

1.1.10 Research Priorities

In 2018 the Lancet published a series of three papers to highlight the burden, challenges, and future direction of the management of LBP (Buchbinder et al. 2018; Foster et al. 2018; Hartvigsen et al. 2018). The first paper considered the multi-dimensional contributors to LBP and disability and the increasing burden and cost (Hartvigsen et al. 2018). The second paper reviewed the current guidelines, highlighted the lack of research into prevention and the gap between and evidence and current practise (Foster et al. 2018). The final paper in the series (Buchbinder et al. 2018) recommended using the concept of positive health when treating people with LBP, which is defined as the '*the ability to adapt and to self-manage in the face of social, physical, and emotional challenges*' (Huber et al. 2016, p.10). They called for the development and implementation of strategies to tackle modifiable risk factors, promote a healthy lifestyle and to integrate LBP care with initiatives in public health. This is not the first time that there has been a call to action in how LBP should be best managed, in 1999 Waddell published '*The back pain revolution'* stating that '*LBP is a 20th century medical disaster*' and called for a radical reassessment of the how we treat LBP (Waddell 1999, p.1). There are many reasons why the burden of LBP has increased despite the increasing volume of research in this field. CLBP is a complex condition (Chrvala and Sharfstein 1999), managing it may require a complex intervention and as Foster et al. (2018) demonstrated there is a gap between the evidence and practice in some settings. When there is lack of progress in a field, it is important that research does not simply evaluate what is already provided but that new modalities and different ways to deliver treatment are also considered (Lewis and O'Sullivan 2018). This could include considering new rehabilitation and self-management tools such as swimming, which could be delivered in the community, targeting not just LBP but also some of the comorbidities associated with this complex condition.

In 2017 Swim England published an independent study exploring the impact of swimming on physical, mental, and social wellbeing (Swim England 2017c). The authors suggested that swimming and aquatic exercise could have a significant impact in supporting the health of the general population due to the unique properties of water. The report identified that although there is a larger body of research exploring aquatic exercise, there is limited research exploring the effects of swimming on musculoskeletal health and it was recommended that

further high-quality research is required, due to the additional benefits of swimming on all-cause mortality and falls in older adults. To promote the value of swimming Swim England, share testimonials whereby swimming has had a positive impact on health (Swim England 2019c) and several books have been published by people who have discovered and use swimming to manage and improve their physical and mental health (Deacon and Allan 2019; Hemingsley 2017; Landreth 2017). Although these stories are of interest, they have limited value as they are single person case studies. To date there has been no attempt to use research methods to evaluate and synthesise the experiences of swimmers to identify whether there are common themes in these stories and experiences.

Over the last few years, the media has shared articles that call for pool and outdoor swimming to be prescribed by health professionals to help a range of long-term conditions (Foote 2022; Swim England 2019d; Wild Swimming Cornwall 2021). If this recommendation is to be taken forward and people are to be encouraged and supported to use swimming, then more research needs to be conducted in this field with different patient populations. Evidently, simply advising swimming to people with CLBP, should not be considered a simple intervention. Swimming provided as a rehabilitation modality for people with CLBP would be a complex intervention due to the nature of the condition, impact of comorbidities, the knowledge and skills required, the variability in which swimming is practiced, the barriers and the impact of behaviour (Craig et al. 2008).

The aim of this PhD project was to develop and assess the feasibility of a swimming programme as a rehabilitation modality for people with CLBP. The project topic aligns with two of the CSP top ten research priorities; '*What methods are effective in helping people make health changes, engage with treatment or manage their health after discharge?*' and '*What approaches are effective for enabling people manage their own health problem?*' (CSP 2018) Aligning the project with CSP research priorities ensures that research resources such as funding, capacity and time are directed for optimal impact in the field of CLBP rehabilitation (Fleurence and Torgerson 2004; Terry et al. 2018)

1.2 Theoretical Frameworks

When developing a complex intervention such as rehabilitation modality it is important to develop a theoretical understanding of the intervention by reviewing the current evidence and theory (Craig et al. 2008). Theories provide researchers with a map and framework with which to view complex problems (Reeves et al. 2008). In the case of this research project, theories provide a conceptual understanding of the interacting factors impacting CLBP, rehabilitation, and swimming. Theories can be defined as '*abstract description of the relationships between ideas, statements and concepts that help us to understand the world*' and theoretical frameworks are a connected set of concepts which have been developed from one or more theory (Varpio et al. 2020, p.991). Models can provide a schematic representation of a theory or theoretical framework (Wunsch 1994). The theoretical framework is the base from which new knowledge is constructed; supporting the rationale, the formulation of research questions, the study design, and the data interpretation (Grant and Osanloo 2014; Reeves et al. 2008). There are many theories and frameworks to choose from, therefore it is important to critically evaluate the quality of the theory, the current evidence base supporting the theory, and ensuring that the theory applies to the study population in question (Davidoff et al. 2015). The following theoretical frameworks have been used to systematically gain an understanding of this research problem, guide the scope of the project, the research questions, objectives, and methodology and ultimately to design a swimming programme for people with CLBP:

- COM-B model and Behaviour Change Wheel (BCW) (Michie, Atkins, and West 2014)
- Swim England and the STA adult learn to swim frameworks (STA 2023; Swim England 2022c).
- Medical Research Council (MRC) framework (Campbell et el. 2000; Skivington et al. 2021)

1.2.1 COM-B and BCW

When delivering rehabilitation behavioural change interventions and techniques can improve uptake and engagement in exercise in people with chronic musculoskeletal pain (Marley et al. 2017; Meade et al. 2019). The COM-B model and the BCW provide a theoretical framework which can be used to analyse and develop behaviour change interventions (Michie, van

Stralen and West 2011; Michie, Atkins, and West 2014), see Figures 2 and 3. Applying the COM-B and BCW as a framework and analysis tool can provide a theoretical insight into both the person and systems level considerations. This framework includes three stages: the COM-B model, which is an interacting system used to understand behaviour, and the BCW which helps identify interventions and policies. The COM-B model accounts for capability, opportunity, motivation, and behaviour. At the start of this project an analysis was undertaken based upon what is known about swimming and CLBP, barriers and enablers and rehabilitation modalities for this population. The analysis was based on the method recommended by Michie, Atkins, and West (2014).

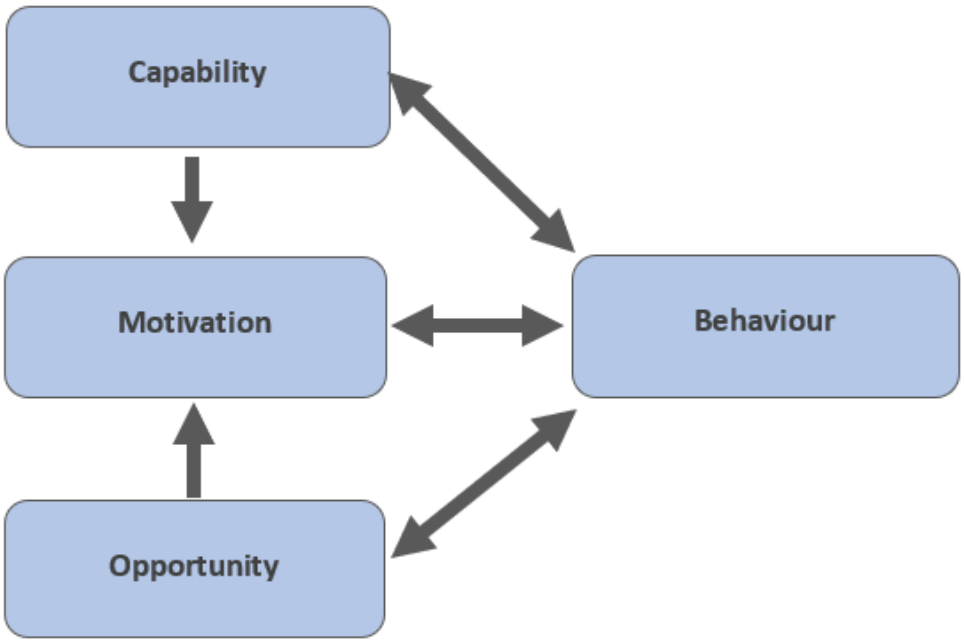

Figure 2: COM-B model (Michie, Atkins and West 2014)
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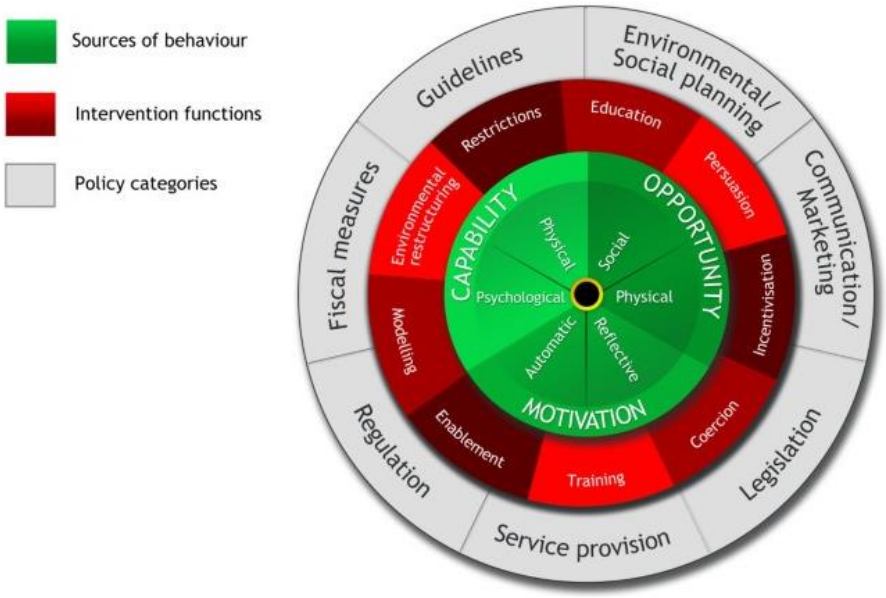

Figure 3: COM-B and BCW (Michie, Atkins, and West, 2014)
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1.2.1.1 Stage one - Understanding the behaviour

In behavioural terms, the problem presented in this project has focused on exercise and people with CLBP are the target population. The specific target behaviour is swimming, which could take place in a swimming pool, twice a week, in a group setting. The COM-B model helps identify what needs to change and is broken down into capability, opportunity, and motivation. In terms of capability, the participants would need to have a better understanding of swimming, swimming skills and overcome physical and mental restrictions and comorbidities. Under opportunity, the swimming session would need to be easily accessible, and they would need support from professionals and peers. For motivation, they would need to develop a stronger sense that swimming and increased physical activity was a good thing to do and develop a habit of swimming regularly. Motivation is an important factor in promoting sustained exercise engagement (Teixeira et al. 2012). The arrows in the model illustrate the interplay between the COM-B components and highlight that both capability and opportunity need to be present in order for motivation to generate a change in behaviour (Michie, Atkins and West 2014). In practice this means having the motivation to swim will not enable a person to swim unless they have the capability and opportunity to do so.

1.2.1.2 Stage two - Identifying intervention options

When considering swimming as a rehabilitation modality, the following intervention strategies could be used: education, training, enablement, and environmental restructuring. Education and training may include the provision of swimming sessions run by swimming and health professionals, aiming to increase both swimming and pain management skills. Enablement is an intervention which aims to reduce barriers and increase capability and opportunities. Environmental restructuring refers to changing the physical and social context, for example providing sessions in a pool in the community, not a hospital. Capability and motivation can be enhanced through training, education, and enablement. Opportunity can be improved by restructuring the environment and training. This stage also includes identifying policies which would support the delivery of the intervention, these policies link with the selected intervention functions. In the case of this project, service provision would be the most appropriate policy category.

1.2.1.3 Stage three - Implementation options

Stage three involves identifying the relevant behavioural change techniques (BCTs) and the mode of delivery. The BCT taxonomy includes 93 items grouped into 16 categories. Based upon evidence from systematic reviews and from the analysis using the COM-B and BCW, the following BCTs could be selected for this project: feedback on swimming, information about health consequences of swimming, demonstration, and instruction on how to swim, feedback and self-monitoring of swimming, social support via the group, goal setting and identity associated with changed behaviour. These BCTs link with enablers to exercise identified in the literature such as the need for extra support and supervision from a health professional and preference for group exercise (Boutevillain et al. 2017). Systematic reviews have found that there is moderate evidence that social support, goal setting, instruction and demonstration of behaviour and practice of the behaviour improves adherence to physical activity (Marley et al. 2017; Meade et al. 2019).

1.2.1.4 Stage four - APEASE

Interventions should be designed and evaluated with consideration of the social context to increase the chance for implementation; this can be done through the APEASE criteria. The acronym APEASE stands for; **A**ffordability, **P**racticability, **E**ffectiveness and cost-effectiveness, **A**cceptability, **S**ide effects / **S**afety and **E**quity. Swimming as a rehabilitation modality would need to be compared to other therapies and modalities offered by the NHS. A pre-block contract for a physiotherapy session at EKHUFT is £32 a session. Delivering swimming to patients with CLBP would involve the following costs: pool hire and payment for a physiotherapist and swimming professional. This modality would only be affordable and cost effective if provided in a group setting, this would be in line with the NICE LBP guidelines which recommend group exercise (NICE 2016). A detailed cost analysis could be undertaken as part of a feasibility study to help establish whether it is practical to provide swimming as a rehabilitation modality for this population, and whether it can be done with existing resources. Effectiveness, acceptability, side effects and safety could also be assessed via a feasibility study, through questionnaires, verbal feedback, risk assessments and follow up appointments. Demographic data and funding could help ensure that people from low socioeconomic and minority groups have an equal opportunity to take part in a study, with sufficient funding to support travel and equipment costs.

This behavioural change analysis provided a theoretical insight into both the person and systems level considerations when using swimming as a rehabilitation modality for CLBP. The analysis highlighted that people would need to have a better understanding of swimming, swimming skills and overcome physical and mental restrictions and comorbidities, the swimming sessions would need to be easily accessible, they would need support from professionals and peers, and develop a stronger sense that swimming and increased levels of physical activity was a good thing to do and develop a habit of swimming regularly. This behaviour change analysis has been used to guide the development of the research and swimming programme objectives. The analysis supports the need for the development of a swimming programme for people with CLBP. It was recognised, based upon this analysis that a learn-to-swim framework would need to be followed if swimming was provided as a rehabilitation modality and for this reason the subsequent section reviews learn-to-swim frameworks.

1.2.2 Theoretical Domains Framework (TDF)

The Theoretical Domains Framework (TDF) could have been used alongside the COM-B and BCW providing another theoretical lens to understand behavioural factors impacting swimming (Michie, Atkins and West 2014). The 14 domains in the TDF were developed based upon the synthesis of 33 behaviour and behaviour change theories (Atkins et al. 2017). The domains include knowledge, skills, social / professional role and identity, beliefs about capabilities, optimism, beliefs about consequences, reinforcement, intentions, goals, memory, attention and decision processes, environmental context and resources, social influences, emotion and behavioural regulations (Phillips et al. 2015). The TDF domains can be mapped onto the COM-B model, some domains map onto one source of behaviour on the COM-B model for example the social influences TDF domain maps onto social opportunity on the COM-B model (Atkins et al. 2017; Michie, Atkins and West 2014). In other cases, several TDF domains map onto one source of behaviour for example the knowledge, memory, attention and decision processes and behavioural regulation TDF domains all map onto psychological capability on the COM-B model (Atkins et al. 2017; Michie, Atkins and West 2014). The TDF was not chosen as a framework for this project as it was originally designed to be used in implementation research (Atkins et al. 2017). If implementation research was undertaken in the future and this present project identified that reflective motivation and psychological capability were key dimensions impacting the behaviour of swimming, then the TDF could provide an additional theoretical lens.

1.2.3 Learn-to-swim Frameworks for Adults

The most common learn-to-swim frameworks for adults used in England were developed by Swim England and the STA following consultation with swimming professionals and experts in the industry (STA 2023; Swim England 2023c). The Swim England and STA adult learn-to-swim frameworks comprise of progressive stages; enabling swimmers to develop water confidence, learn aquatic skills and swimming strokes, and improve their swimming technique (STA 2023; Swim England 2023c). The Swim England water confidence stage for novice and nervous swimmers aims to give swimmers to confidence to get in and out of the pool safely and move around the pool. The second stage aims to provide swimmers with the skills to swim a short distance independently, the third stage aims to enable swimmers to swim

further, and the final stage is for swimmers wishing to compete (Swim England 2023c). The STA has similar stages to the Swim England framework (STA 2023). Both frameworks have aims and learning outcomes; listing activities to accomplish.

The Halliwick concept is a swimming framework used with people with disabilities by some aquatic physiotherapists as part of an aquatic therapy programme. It aims to teach core aquatic and swimming skills, enabling people to swim, and become independent in the water and is usually used with people with neurological conditions and children, although could be considered for anyone with a disability (Lambeck and Gamper 2009). It has some similarities to approach taken by Swim England and the STA (STA 2023; Swim England 2023c) in that it focuses on the core aquatic skills as building blocks to teaching the swimming strokes, however it is not usually delivered in a group setting as it was designed to be delivered to people with more significant disabilities.

The STA, Swim England or Halliwick learn-to-swim frameworks could be used with people with CLBP however due to the nature of the condition it is likely they would need to be adapted so that swimming could be utilised as a rehabilitation modality for this population. It was recognised that people with CLBP wishing to use swimming as a rehabilitation tool would benefit from developing water confidence, learning core aquatic skills, and swimming strokes, and developing swimming technique. However, several uncertainties would need to be addressed including identifying which strokes to swim, whether strokes should be adapted and how often or how long to swim. Furthermore, a swimming programme developed as a rehabilitation modality for people with CLBP could also encompass pain management skills such as pacing, graded exercise, adaptations, problem solving and relaxation (Lamb et al. 2010; O'Sullivan et al. 2018; Pain tool kit 2023). The recognition that existing frameworks might need to be adapted supported the rationale for developing a swimming programme for this population.

1.2.4 MRC Framework

Earlier in this chapter it was recognised that CLBP can be a complex, multidimensional condition influenced by several interacting systems and that rehabilitation is a multi-component complex intervention. Complexity theory has become more popular in healthcare research over the last 20 years, due to the recognition that long-term conditions and

healthcare systems are complex (Long, McDermott and Meadows 2018). Complex systems have many characteristics; these include having a large number of elements, interaction of elements in a nonlinear manner, open systems and systems which evolve through time (Cilliers 1998). The characteristics of complex systems can make conducting research in the field a challenge, however models for understanding complex adaptive systems can guide researchers undertaken research involving complex conditions and interventions. Based upon a matrix developed by Stacey (1996), it has been suggested that in healthcare conditions, events and interventions can be simple, complex, or chaotic (Brown 2006). When undertaking research, a simple intervention will offer a high level of certainty and agreement, whereas a chaotic intervention will result in a low level of certainty and agreement; a complex intervention is found between these two extremes (Brown 2006), see Figure 4. Although the recommendation of swimming could be viewed as a simple intervention, based upon the discussion points covered earlier in the chapter it could be suggested that the current use of swimming by people with CLBP is often a chaotic intervention. It is proposed that by developing a swimming programme or guidelines the intervention would still be complex but not chaotic.

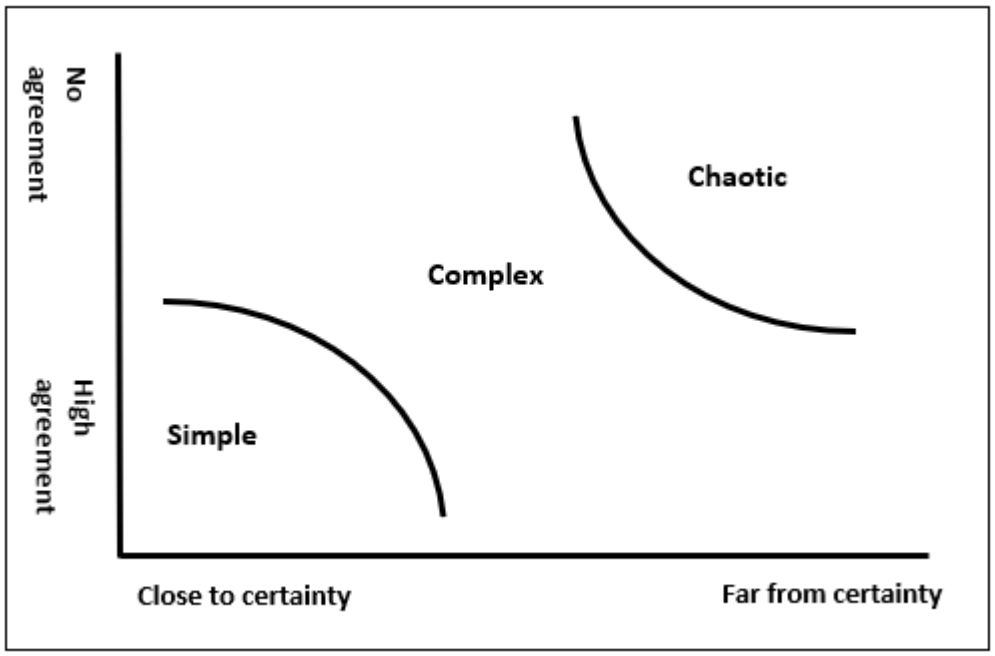

Figure 4: Complexity matrix (Brown 2006)

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The MRC framework for developing and evaluating complex interventions, defines phases in the research process, helping researchers understand where they are in the research pathway, the framework can be found in Figure 5 (Campbell et el. 2000; Skivington et al. 2021). Unlike the linear development of a drug, for many complex interventions an iterative process is preferable, using both qualitative and quantitative methods (Campbell et el. 2000; Craig et al. 2008). Recommending swimming to people with CLBP could be viewed as a simple intervention but when delivered as a rehabilitation modality it is a complex intervention. The authors of the MRC framework explain how interventions can be complex due to the impact of behaviour, the skills required to deliver the intervention and the skills required by the person receiving the intervention (Skivington et al. 2021). In the case of this research project, other factors which increase the complexity include the variability in the experience and impact of CLBP, the impact of other comorbidities, the number of ways that swimming can be practiced and taught and the impact of behaviour on uptake. The updated version of the framework (Skivington et al. 2021) looks beyond whether the intervention is simply effective and questions whether it can be implemented in a real-life setting, with this in mind core elements now include stakeholder consultation, and consideration of uncertainties, the context and cost in all four phases.

The MRC framework recommends four phases when researching complex interventions; identification or development of an intervention, feasibility, evaluation, and implementation; these phases do not need to be sequential (Campbell et el. 2000, Craig et al. 2008). There are also core elements at the heart of the updated framework, which include consideration of context, programme theory, stakeholders, key uncertainties, intervention refinement and economic considerations (Skivington et al. 2021).

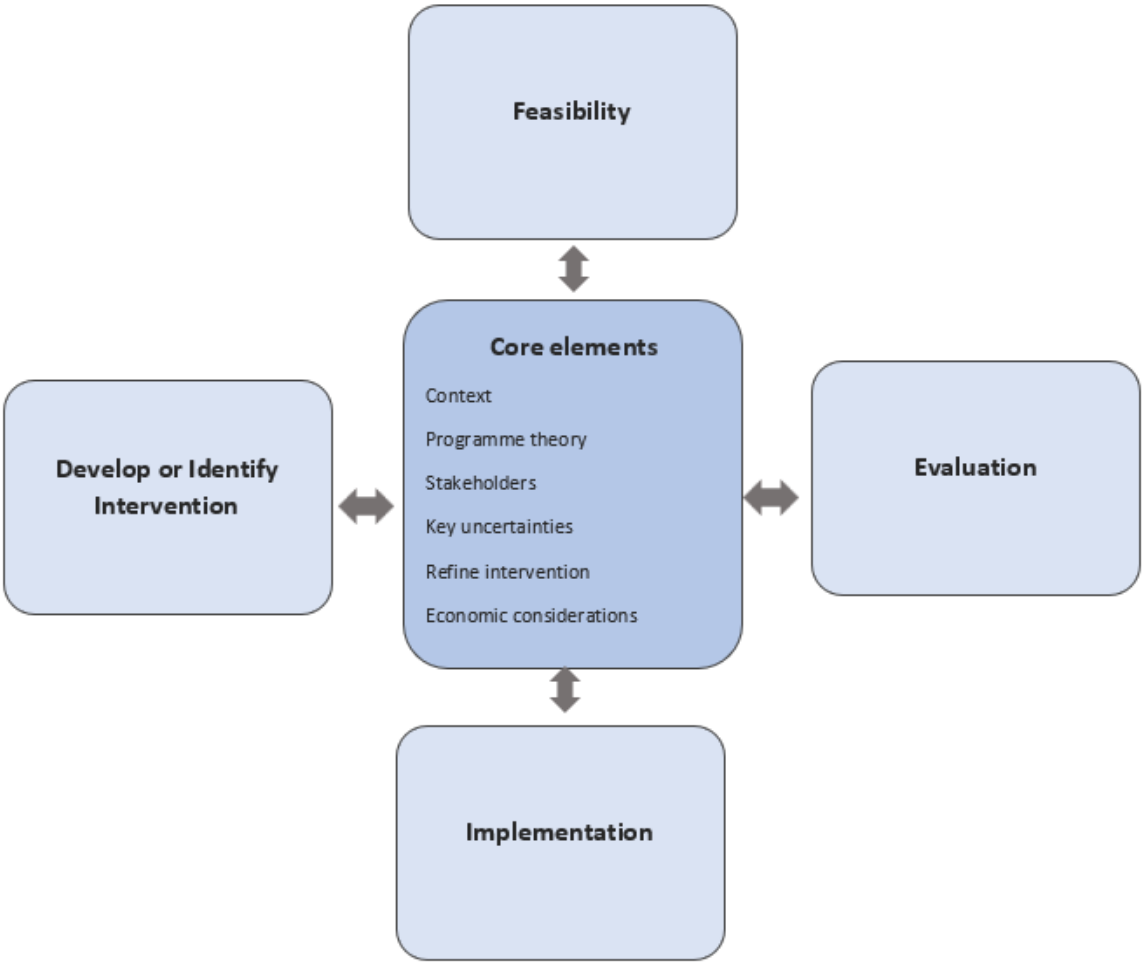

Figure 5: MRC Framework (Skivington et al. 2021)

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1.2.3.1 Developing and identifying a complex intervention phase

The first section of the introduction chapter set out the rationale supporting why swimming could offer additional practical and therapeutic benefits to aquatic therapy for people with CLBP when used as a rehabilitation modality. The rationale section of this chapter would fit into the '*identification of an intervention'* phase of the MRC framework in that stakeholders were identified, and key uncertainties were considered. The framework recommends that programme theory is utilized at all stages when undertaking complex intervention research (Skivington et al. 2021). Programme theory and the use of logic models, realist matrix or system maps can help researchers develop a schematic representation, helping to theorise the intervention before it is evaluated (Skivington et al. 2021). Analysis should include the

recognition that there could be both benefits and risk or harm from an intervention (Bonell, Melendez-Torres, and Cummins 2015). For example, risks associated with swimming could include flare up of pain, fatigue, and post exercise soreness (Darlow et al. 2016), or adverse reactions to swimming or pool water (Agius, Pickles, and Burch 1992; Fernandez-Luna et al. 2016; Ishioka et al. 2008). The logic model can then be revisited after the evaluation and before further research is undertaken. To support the rationale for a swimming programme being provided as a rehabilitation modality, a logic model was produced, based upon the COM-B and BCW analysis, learn-to-swim swimming frameworks and the literature review, see Figure 6.

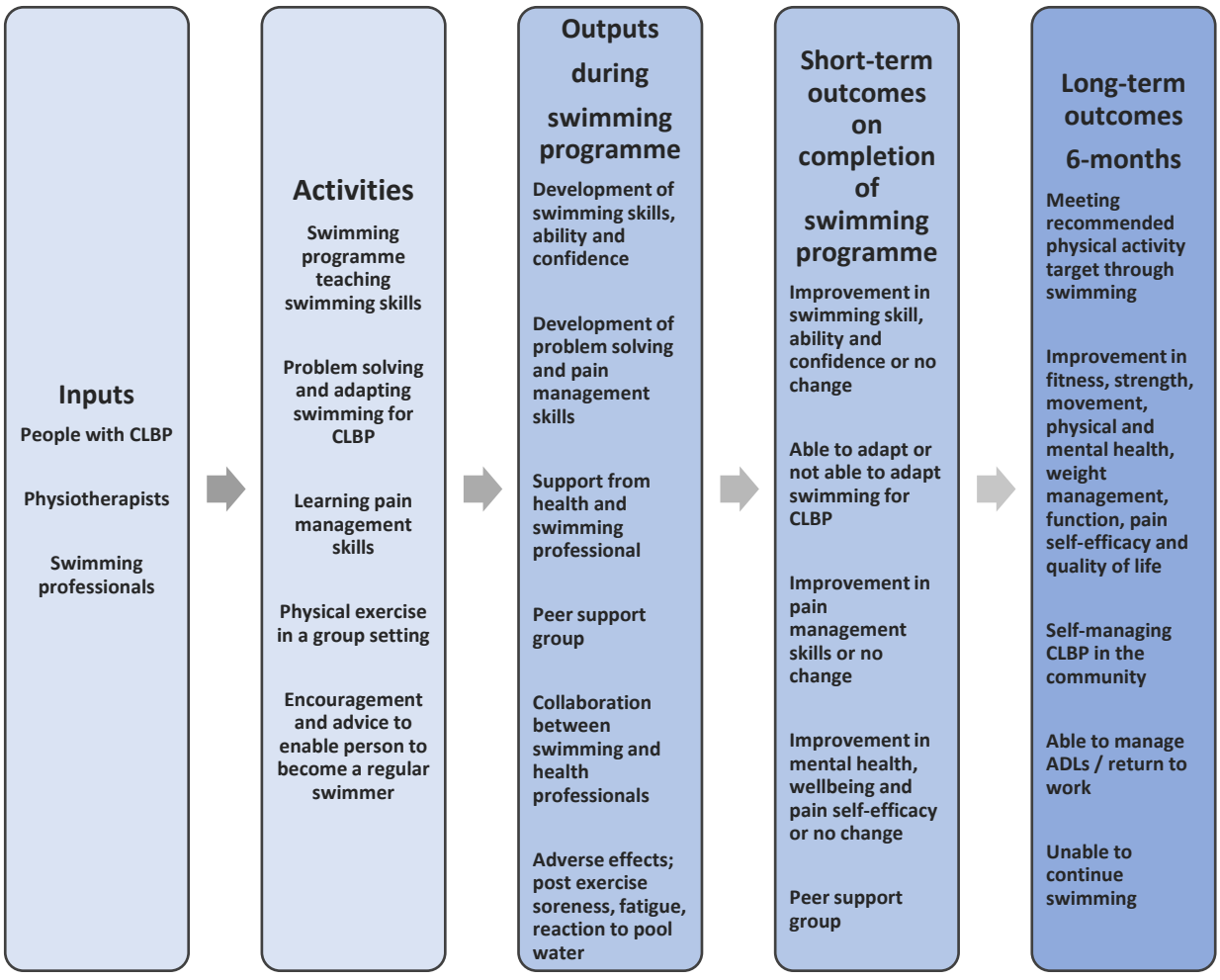

Figure 6: Logic model for delivering a swimming programme as a rehabilitation modality to people with CLBP

The MRC framework '*development of an intervention*' phase suggests that existing interventions could be reviewed when developing an intervention, considering whether they could be adapted to a new population or used to target other outcomes (Skivington et al. 2021). The scoping review in chapter two, identified four published interventional studies whereby swimming was used as part of a rehabilitation programme for people with LBP; the findings suggested that swimming could be tolerated by people with CLBP (Ariyoshi et al. 1999; Kim, Jung, and Kim 2008; Weifen et al. 2013; Winter and McCauley-Callagy 2002). The study procedures could provide some initial guidance on possible methods for delivering swimming, however it was identified that the programmes delivered in all four studies varied considerably and were all delivered as part of a multi-modal treatment. Swimming programmes published in aquatic exercise manuals for people with CLBP were also reviewed (Cole et al. 1997; Dunlap 2009). It was found that these programmes were not in alignment with current understanding of CLBP and rehabilitation. In the past people with CLBP were advised to stabilise the spine when swimming (Cole et al. 1997; Dunlap 2009), however current land based CLBP rehabilitation programmes have moved away from this approach to encouraging more relaxed functional movements (O'Sullivan et al. 2018).

Aquatic therapy has some common elements to swimming; there have been several clinical trials conducted involving people with LBP (Heidari, Mohammad Rahimi and Aminzadeh 2023; Shi et al. 2018). Parameters such as the time spent in the water and frequency of the sessions reported in these aquatic therapy studies could be considered when developing the swimming programme. Guidance on delivery of aquatic therapy has also been produced by the clinical interest known as the ATACP (ATACP 2021), this could provide an initial framework when screening and delivering swimming to people with CLBP. Furthermore, the STA and Swim England adult learn-to-swim frameworks could provide guidance on teaching core aquatic and swimming skills to adults (STA 2023; Swim England 2023c).

When designing a new intervention, it is important to state the objectives of the intervention so that the stakeholders involved in the development are able to work towards a common purpose. In the case of this project the objectives were based upon the COM-B and BCW analysis, existing swimming and aquatic frameworks and the logic model presented in Figure 5; eight objectives were initially set for this swimming intervention. The wording of the objectives was revised to combine certain objectives leaving four objectives, see Table 3.

Table 3: Objectives of swimming programme

Final wording of swimming programme objectives	Initial wording of swimming programme objectives	Logic model	COM-B and BCW	Swimming and aquatic frameworks	Rationale literature review
1.To improve confidence swimming with CLBP, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for CLBP	1.To improve a person's confidence so that they can swim despite their CLBP. 2.To improve swimming ability by teaching aquatic skills to improve swimming and a swimming stroke that is adapted for CLBP.	Activity, outputs, short-term outcome	Physical and psychological capability Physical and social opportunity Education, training, enablement	Swimming ability and aquatic skills (STA 2021b; Swim England 2022) Adapting swimming for LBP (Winter et al. 2002)	Swimming ability (Swim England 2019b)
2.To integrate pain management skills with swimming	3.To integrate pain management skills with swimming; including acceptance, setting goals, and making an action plan, pacing, increasing activity slowly, improving support networks, having a setback plan, managing stress, and making time to relax.	Activity outputs, short-term outcome	Physical and psychological capability Education, training, enablement	None	NICE LBP and sciatica guidelines (2016) Pain tool kit (2023)
3.To recognise and address barriers to swimming and enable people with CLBP to become regular swimmers	4.To help the person recognise and overcome what might stop them from swimming. 5.To encourage the person to continue swimming regularly once they have finished the class.	Activity, long-term outcome	Reflective motivation Enablement, education	None	Aquatic exercises (Fisken et al. 2016; Hornsby 2016) Chronic pain (Boutevillain et al. 2017; Joelsson et al. 2017; McPhail et al. 2014; Vader et al. 2021) Swimming (Swim England 2017)

4.To use swimming to improve function, physical activity, quality of life, physical and mental health, and weight management	6.To improve and increase what the person is able to do each day. 7.To improve the person's quality of life, physical and mental health through swimming regularly. 8.To be used as a tool to help the person maintain a healthy weight.	Long-term outcome	Reflective motivation Education and training	Using swimming to increase physical activity in people with LBP (Ariyoshi et al. 1999)	Physical health (Pai et al. 2015; Pozzobon et al. 2019), Schneider et al. 2006; Williams et al. 2018) Mental health (Hagen et al. 2006; Schmelzer et al. 2016) Weight management (Frilander et al. 2015; Green et al. 2018; Janke and Kozak 2012; Suri et al. 2017) Physical activity (Ferreira et al. 2013; Shiri and Falah-Hassani, 2017)

The analysis using the logic model highlighted potential benefits and risks of using a swimming programme as a rehabilitation modality and helped develop objectives for this swimming intervention. The COM-B and BCW analysis described both the person and system level considerations when using swimming as a rehabilitation modality. The theoretical analysis undertaken using these frameworks goes towards meeting the phase 1 recommendations from this MRC framework.

1.2.3.2 Feasibility phase

The second phase in the MRC framework addresses feasibility; a feasibility study asks whether a study can be carried out, how to proceed with the study and if so, how this could be delivered (NIHR 2021). It has been suggested that all studies carried out to prepare for a main study, will assess feasibility (Eldridge et al. 2016). Due to the limited research and key uncertainties, this was the other phase where this present project sits, it was necessary to consider all of the core elements in the MRC framework at this stage. It was evident that there could be several contexts in which the swimming programme could be delivered: namely in a hospital hydrotherapy pool, in a community leisure centre pool or outdoors. There was no evidence to suggest that one context was preferable to another, so the initial stages of the project did not seek to specify the context. The logic model had highlighted the inputs, activities, outputs, and short-term and long-term outcomes with regards to swimming as a rehabilitation modality. The stakeholders identified to develop, deliver, and take part in this project were physiotherapists, swimming professionals and people with CLBP. It was clear that one study would be insufficient and that the study objectives should be based upon the key uncertainties set out in this chapter. This analysis using the MRC framework suggested that the project could be positioned in a pragmatist paradigm and use mixed methods to address the project aim and objectives; the reasoning behind the project design will be discussed in the methodology chapter.

1.3 Research Project

1.3.1 Aim

To develop and explore the feasibility of a swimming programme as a rehabilitation modality for people with CLBP.

1.3.2 Objectives

- To review the current evidence base supporting to recommendation of swimming to people with LBP.
- To identify the most common barriers, enablers, and preferences to swimming for people with CLBP.
- To explore the experience of swimmers who use swimming to manage CLBP.
- To develop a swimming programme as a rehabilitation modality for people with CLBP, consulting swimming professionals, physiotherapists, and people with CLBP.
- To assess the feasibility of the swimming programme as a rehabilitation modality for people with CLBP.
- To assess the feasibility of conducting a sufficiently powered RCT comparing the swimming programme to standard physiotherapy care.
- To combine the data from all four studies and draw meta inferences to enable refinement of the swimming programme.

1.4 Thesis Structure and Outline of the Chapters

This thesis is organised into ten chapters:

Chapter One: Introduction, theoretical frameworks, project aims and objectives.

Chapter Two: Recommending swimming to people with LBP: A scoping review.

Chapter Three: Methodology

Chapter Four: Study one: Survey of the barriers, enablers, and preferences to swimming for people with CLBP.

Chapter Five: Study two: Learning to swim with back pain: a qualitative study of swimmers with CLBP.

Chapter Six: Study three: Development of a swimming programme as a rehabilitation modality for people with CLBP using the modified Delphi technique.

Chapter Seven: Study four: Swimming as a rehabilitation modality for people with CLBP versus routine physiotherapy care: A mixed methods feasibility study.

Chapter Eight: Meta inferences: Refinement of the swimming programme through the integration and analysis of data from four studies.

Chapter Nine: Discussion and recommendations for future work.

Chapter Ten: Conclusions

1.5 Summary

The introduction chapter has presented the background and rationale for the thesis, initially exploring the epidemiology and complexity of CLBP. The key recommendations of group exercise and self-management from the NICE guidelines for LBP and sciatica have been discussed alongside how the guidelines translate into physiotherapy practice. It was noted that aquatic therapy is provided by physiotherapists as a rehabilitation modality, and swimming is often recommended to people with CLBP. It was suggested that swimming could have additional benefits to aquatic therapy including targeting some of the comorbidities such as obesity, cardiovascular disease, and depression, which can be associated with CLBP. The chapter explored gaps in service provision, determinants impacting engagement in swimming and key uncertainties, which could translate to conflicting advice from health and swimming professionals when advising swimming. The rationale section concluded with a review of research priorities in the field of CLBP and considered how rehabilitation modalities such as swimming, align with these priorities. In the second part of the chapter the following theoretical frameworks were reviewed: the COM-B and behavioural change wheel, the Swim England and STA adult learn to swim frameworks and the MRC framework. The chapter explained how these frameworks were used in this thesis to develop a theoretical understanding of swimming as a rehabilitation modality and guided the research design, aims and objectives and the swimming programme objectives. Chapter two will review the literature related to swimming and CLBP, in order to gain an understanding of the current evidence base supporting the recommendation of swimming to people with CLBP.

Chapter 2: Scoping Review

Recommending Swimming to People with Low Back Pain

2.0 Introduction

The introductory chapter highlighted that when recommending swimming to people with CLBP, health professionals can encounter several uncertainties. First and foremost, it is not known which swimming strokes or combinations of strokes could be beneficial for someone with LBP and whether certain strokes such as breaststroke should be avoided (Hofling et al. 2002, Liyanage 2020). Furthermore, swimming ability and stroke technique can vary between individuals (Coleman, Persyn, and Winters 2000, Newsome and Young 2012; YouGov 2016) and the impact of swimming and the swimming strokes on the spine and LBP is unknown (Ribaud et al. 2013). To date, only two systematic reviews have been undertaken exploring the recommendation of swimming with people with LBP both reviews concluded that there was a scarcity of research in this field (Pocovi et al. 2022; Ribaud et al. 2013). In healthcare, systematic reviews are conducted to confirm or refute current practice, guidelines, or recommendations (Munn et al 2018), whereas scoping reviews identify and map the current evidence, describing the types of methods used and highlighting gaps in knowledge (Peters et al. 2015). A scoping review exploring the current evidence base for the recommendation of swimming to people with LBP would help map the existing research in the field, helping guide health professionals when advising swimming and direct future research.

The aim of this scoping review was therefore to review the current evidence base supporting the recommendation of swimming to people with LBP.

2.1 Method

2.1.1 Search Strategy

A scoping review was undertaken based upon the PRISMA-ScR extension for scoping reviews (Peters et al. 2015, Tricco et al. 2018). A search of five electronic databases; CINAHL, MEDLINE, PEDro, PubMed, and SPORTdiscus; was carried out during October 2022. The population included in the review were people with back pain, and the intervention was swimming. For the purpose of this review, the term back pain included conditions characterised by marked discomfort or pain in the back region (ICD10Data.com 2023) and the term swimming referred to the activity of propelling the body through the water, not aquatic therapy. Boolean logic was used to increase search specificity; the following keywords were used: (back pain OR low back pain OR lumbar pain OR chronic low back pain) AND (swim OR swimmer OR swimming). The search included peer review articles and studies in human adults (>18 years) and excluded animal studies. Studies involving aquatic therapy and competitive swimmers were not excluded in the initial search. The key words were chosen based upon the research question and using the PICOS (Population Intervention Comparison Outcome Study) framework (Costantino, Montano and Casazza 2015) which helps convert a research question into key words for a literature search. All physiotherapy modalities were considered as comparisons to swimming to broaden the search and the outcomes of interest were those commonly used in LBP research including pain, function, and quality of life. The search was expanded by reviewing the reference list of the included studies, searching the grey literature, and reviewing the program content of aquatic therapy studies which included people with LBP. The following study designs were considered in the review; observational studies exploring the relationship between LBP and swimming, biomechanical studies exploring the impact of swimming on the spine and interventional studies integrating swimming into a rehabilitation programme for LBP.

2.1.2 Data Extraction and Analysis

The following data was recorded during the screening process: records identified through database searching, additional records identified through other sources, total number of records screened by abstract and title, duplicates removed, full text articles assessed for eligibility, and total number of studies meeting the eligibility criteria. The number of records

excluded was also documented and the reasons for the record not meeting the eligibility criteria. Reasons for papers not being eligible included the findings only being relevant to competitive swimmers; the study involved aquatic exercise not swimming; the study did not include swimming, LBP, or humans; it was not published in the English language; or the paper was a review paper or authors response. The data charting process was undertaken using Excel. The review process is presented in Figure 6 as a PRISMA (preferred reporting items for systematic reviews and meta-analyses) flow chart, showing the numbers of search results and the reasons for studies being excluded. The studies were reviewed and grouped by study design and the following uncertainties were considered: the impact of swimming on the spine and LBP; evidence of swimming increasing or reducing the risk of LBP; and the use of swimming in a LBP rehabilitation programme.

2.2 Results

The search strategy identified 344 citations, 167 duplicates were removed, 138 papers were removed after reading the title and abstract and a further 15 were excluded after reading the full text due to not meeting the eligibility criteria. 25 studies met the eligibility criteria.

2.2.1 Characteristics of Included Studies

The studies included sixteen observational studies exploring the relationship between swimming and LBP, three biomechanical studies investigating the impact of swimming on the spine, and five interventional studies of which four integrated swimming into a rehabilitation program and one used swimming to modify lumbar lordosis. The sample sizes for the observational studies ranged from 38 to 16,394 participants, the biomechanical studies from 19 to 46 participants and the interventional studies from 6 to 98 participants. The greatest number of publications occurred in Japan and the United States of America, 16% (n=4), followed by Finland, 12% (n=3).

2.2.2 Characteristics of Participants

The observational studies included student athletes, college swimmers, competitive swimmers, master's swimmers, leisure/ recreational swimmers, middle age and older adults, and non-athletic populations. The biomechanical studies included recreational swimmers without LBP, skilled breaststroke swimmers with LBP and college swimmers and the interventional studies recruited retired athletes with LBP, automotive workers with LBP and people with LBP.

2.2.3 Risk of Bias

Only one randomised clinical trial was identified in the search (Weifen et al. 2013), this study was assessed for risk of bias in the systematic review and meta-analysis by Pocovi et al. (2022) using the RoB 2 tool (RiskofBias.info 2019). The overall rating was 'some concerns'; the concerns were in the domains of outcome measurement and the selection of the reported results. Three of the interventional studies were single arm studies and the other study in the review included a control group but did not randomise the two groups (Manshouri et al 2014). The risk of bias assessment using the ROBINS-I assessment tool (RiskofBias.info 2016) for this

study was rated as moderate risk of bias, suggesting that it would not be comparable to a well conducted randomised trial but provided sound evidence for a non-randomised trial. The areas of moderate risk of bias were selection of participants and selection of reported results.

The PRISMA flow chart can be found in Figure 7 and the studies included in the review have been summarised documenting reference, country, participants, study design and main findings in Tables 4, 5 and 6.

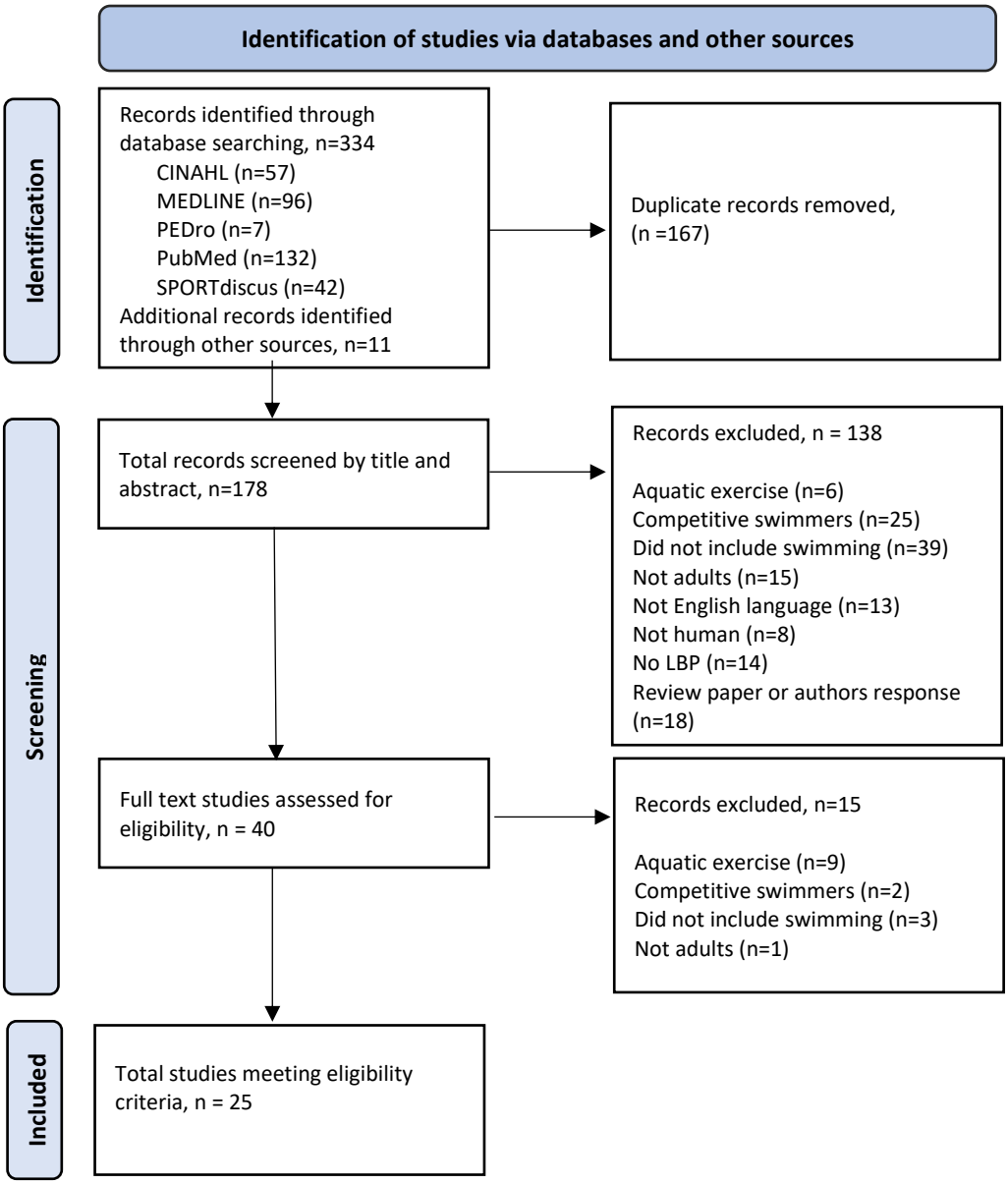

Figure 7: PRISMA flow chart of search results and study selection

Table 4: Observational studies (n=16)

Reference	Country	Participants	Study design	Main findings
Almeida (2015)	Brazil	257 elite swimmers	Cross-sectional survey	6.2% experienced LBP
Atilla (2020)	Turkey	88 Male Masters swimmers (26-89 years)	Cross-sectional survey	27% experienced LBP
Cabri (2001)	Portugal	146 elite swimmers and 119 leisure swimmers	Cross-sectional retrospective survey	Competitive swimmers had a smaller lifetime and one year pain prevalence than leisure swimmers
Capaci (2002)	Turkey	38 competitive male swimmers	Survey	18.4% had LBP, there was a significant relationship between the time spent training each week and the number of years of training and musculoskeletal pain
Folkvardsen (2016)	Finland	100 elite swimmers and 96 people not involved in sport	Cross-sectional comparative study	Incidence of degenerative disc disease was similar between the two groups. Lower levels of correlation between herniated discs and LBP in the swimmers (68.4%) than the people not involved in sport (90%)
Hangai (2009)	Japan	308 university athletes to 71 non-athletic university students	Cross-sectional study	Swimmers who trained during their youth had a significantly greater proportion of degenerative changes when compared to non-athletes and that there was a relationship between lifetime LBP and disc degeneration.
Harreby (1997)	Denmark	578 38-year-old women and men	Prospective cohort study	Being physically active for more than three times a week reduced the incidence of LBP. 68% of participants found that swimming improved their LBP and 16% of participants reported swimming aggravated their LBP.
Junqueria (2014)	Australia	38 twin pairs	Cohort study	Moderate exercise such as gentle swimming was not associated with chronic LBP, whereas low level or more strenuous physical activity had a positive association.
Kaartinen (2020)	Finland	4246 adults	Cross-sectional survey	More LBP in those who engaged in swimming and walking, but not significantly significant.

Kaneoka (2007)	Japan	38 elite swimmers and 38 recreational swimmers	Case control study	Disc degeneration was greater in elite compared to leisure swimmers. They found no significant relationship between LBP symptoms, disc degeneration and swimming strokes.
Kovacs (2003)	Mallorca	16,394 School children and parents	Cross-sectional population survey	Swimming was significantly associated with LBP, but not associated with the practice of other sports.
Mundt (1993)	USA	155 people with disc herniation	Cross-sectional survey	Relative risk for swimming and disc herniation was close to 1.0, no increase in the risk of disc herniation
Noormohammaspour (2016)	Iran	1335 female university student athletes	Cross-sectional survey	Swimmers had the lowest lifetime prevalence for LBP, 47.8 %
Suri (2015)	USA	424 older adults	Cross-sectional study	No significant increased risk in lumbar zygapophyseal osteoarthritis in those who were swimming regularly
Triki (2015)	Tunisia	5958 students	Cross-sectional survey	Swimmers had the lowest prevalence of LBP, with only 1.6% of swimmers reporting LBP
Wolf (2009)	USA	94 Collegiate swimmers	Retrospective review	12.8% experienced LBP

Table 5: Biomechanical studies (n=3)

Reference	Country	Participants	Study design	Main findings
Coleman (2000)	Belgium	25 skilled breaststroke swimmers with LBP	Video biomechanical analysis of breaststroke	Stroke analysis found seven abnormal phases in the stroke which could cause LBP. The stroke abnormalities either related to hyperextension in the spine or poor body balance.
Du, Narita (2016)	Japan	19 college swimmers	Biomechanical analysis using electromagnetic tracking measuring three-dimensional movement of torso during tethered front crawl swimming	Range of extension in front crawl was much less than the available range of spinal movement and there was no difference in the range of torso extension when breathing was added to the stroke cycle.
Hofling (2002)	Finland	46 recreational swimmers without LBP	Video biomechanical analysis of lumbar lordosis and thoracic kyphosis during breaststroke and backstroke	Lumbar lordosis was less when swimming than when standing and less when swimming backstroke than breaststroke.

Table 6: Interventional studies and systematic reviews and meta-analysis (n=6)

Reference	Country	Participants	Study design	Main findings
Ariyoshi (1999)	Japan	35 people with LBP (25 female and 10 male)	Single arm study, land-based exercise, aquatic exercise, and swimming	Significant improvement in physical scores and swimming ability, more the 90% of participants felt they had improved after 6-months
Kim (2008)	Korea	13 male automotive workers with LBP	Single arm study, land-based exercise, hill walking and swimming	No change in body composition, significantly reduced C reactive protein levels, indicating a reduction in inflammation and improvement in strength and flexibility.
Manshouri (2014)	Iran	98 females with hyper lumbar lordosis	Comparative study, comparing swimming backstroke, walking in water and stretches to a control group	Significant reduction in lumbar lordosis in the experimental group when compared to the control group
Pocovi (2022)	Australia	19 trials 2362 participants	Systematic review and meta-analysis	Only one RCT (Weifen (2013) identified in review involved swimming
Weifen (2013)	China	38 retired athletes with LBP (21 male 17 female)	RCT comparing four interventions (swimming, jogging, backwards walking, and Tai Chi) plus physical therapy	Swimming and physical therapy was more effective at reducing pain at 3 months and 6 months than no treatment and had better outcomes than jogging and backward walking but had similar changes in the intensity of pain to Tai Chi.
Winter (2002)	USA	6 people with LBP (3 male and 3 female)	Single arm study, aquatic exercise, and swimming	Activity of daily living scores improved, and pain scores reduced.

2.3 Discussion

The scoping review identified sixteen observational studies, three biomechanical studies and six interventional studies; these findings support the claim that there is limited research supporting the recommendation of swimming to people with LBP. It was already known, based upon the recent systematic review by Pocovi et al (2022) that there has only been one randomised controlled trial conducted in the field of swimming and LBP. Only four additional interventional studies were identified in this review, of which three were single arm studies and one was an uncontrolled study. The greater proportion of research has been in the form of observational studies, which cannot be used to establish causality. Due to swimming being a sport, most research has been undertaken with competitive swimmers. 27 papers were excluded during screening due to the findings only being relevant to competitive swimmers. Although research involving competitive swimmers provides some understanding of the impact of swimming on the spine and LBP, the findings may not be transferable to leisure swimmers and people with comorbidities. This discussion section, grouped by study design, summarises the studies, consider the implications for people with LBP and make further recommendations.

2.3.1 Observational Studies Involving LBP and Swimming

Four correlational studies were identified exploring the relationship between competitive swimming and LBP. A survey of musculoskeletal pain in competitive male swimmers, reported that 18.4% had LBP and there was a significant relationship between the time spent training each week and the number of years of training and musculoskeletal pain (Capaci, Ozcaldiran and Durmaz 2002). In contrast a cross-sectional survey of female student athletes competing in nine sports found that the swimmers had the lowest lifetime prevalence for LBP, 47.8 % (Noormohammaspour et al. 2016). Likewise, a survey of undergraduate students reported that compared to the other sports the swimmers had the lowest prevalence of LBP, with only 1.6% of swimmers reporting LBP (Triki et al. 2015) and a retrospective study of elite and leisure swimmers found that the elite swimmers had a smaller lifetime and one year pain prevalence than leisure swimmers (Cabri et al. 2001). Two of these studies recruited a young athletic population (Noormohammaspour et al. 2016; Triki et al. 2015), both studies found that the swimmers had a lower lifetime prevalence of LBP when compared to other sports.

However, these findings might not be transferable to older leisure swimmers, as illustrated by the findings by Cabri et al. (2001) which reported different findings in the competitive and leisure swimmers, supporting the need for caution when using data from competitive swimmers to guide recommendations for leisure swimmers. Furthermore, one study found a relationship between training time and musculoskeletal pain (Capaci, Ozcaldiran and Durmaz 2002), again highlighting the significant differences between how swimming is practiced by competitive and leisure swimmers.

Four studies were identified which explored the relationship between leisure swimming and LBP. A prospective cohort study of 38-year-old women and men found that being physically active for more than three times a week reduced the incidence of LBP (Harreby et al. 1997). The participants were asked about whether specific sports affected their LBP; 68% of participants found that swimming improved their LBP and 16% reported swimming aggravated their LBP. Similarly, a cohort study of twins found that moderate exercise such as gentle swimming was not associated with chronic LBP (Junqueria et al. 2014). Conversely another study of twins found that there was a higher rate of LBP in those who reported in engaging in swimming and walking when compared to other activities, but it was not statistically significant (Kaartinen et al. 2020). Likewise, a survey of parents reported that swimming was significantly associated with LBP, but not associated with the practice of other sports (Kovacs et al. 2003). It is important to note that it was not known in the studies where there was an association with swimming and LBP, whether swimming had contributed to the development of LBP or whether swimming was used by this population to help manage LBP and keep physically active. Without follow up qualitative data, it is impossible to draw conclusions, highlighting a limitation of correlational research.

Five correlational studies were identified exploring the relationship between swimming and degenerative changes in the spine including, disc herniation, disc degeneration and zygapophyseal joint arthritis. A cross-sectional study examined the correlation between physical activity, including swimming, with lumbar zygapophyseal osteoarthritis in older adults, and found no significant increased risk in those who were swimming regularly (Suri et al. 2015). Likewise, a cross-sectional survey of people with disc herniation reported that the relative risk for swimming and disc herniation was close to 1.0, meaning that there was no increase in the risk of disc herniation for this form of exercise (Mundt et al. 1993).

Furthermore, a comparative study found that the incidence of degenerative disc disease observed through MRI scans was similar between elite swimmers and those not involved in sport (Folkvardsen et al. 2016). The study discovered that there were lower levels of correlation between herniated discs and LBP in the swimmers (68.4%) than the people not involved in sport (90%). In contrast a cross-sectional study compared degenerative disc disease in university athletes to non-athletic university students (Hangai et al. 2009). They found that swimmers who trained during their youth had a significantly greater proportion of degenerative changes when compared to non-athletes and that there was a relationship between lifetime LBP and disc degeneration. Similar findings were found in a case control study of elite and recreational swimmers, they found that disc degeneration was greater in elite compared to leisure swimmers (Kaneoka et al. 2007), however they found no significant relationship between LBP symptoms, disc degeneration and swimming strokes. The review also identified three studies which reported different rates of LBP injuries in swimmers; ranging from 6.2% in elite swimmer (Almeida et al. 2015), to 12.8% in collegiate swimmers (Wolf et al. 2009), and 27% in male Masters swimmers (Atilla et al. 2020). The higher rates of injuries in the Masters swimmers could reflect the older age range sampled in this study.

Correlational studies are used to explore relationships between two variables; in this case swimming and LBP but cannot establish causality and findings should be interpreted with caution (Argyrous 2012 p.232; Hung, Bounsanga and Voss 2017). The studies had mixed findings with regards to relationship to LBP and degenerative changes in the spine. The studies illustrated that swimmers are a heterogenous population ranging from elite competitive swimmers to leisure swimmers and that correlations found for one swimming stroke, swimming style or swimming volume may not be transferable to other situations. It was evident from this section of the review that the majority of swimming research has been carried out with elite swimmers; however due to much greater training volumes it is unlikely that this form of swimming and the research findings are transferable to leisure swimmers. It has been suggested that physical activity and its correlation with LBP is U shaped; meaning that too little and too much can result in an increased incidence of LBP (Heneweer et al. 2009). It is important to acknowledge in correlational research that other variables and factors will contribute; for example, in the case of elite swimmers, they would probably not have other risk factors for LBP such as being a smoker (Green et al. 2016).

2.3.2 Biomechanical Research

Researchers in sports biomechanics seek to gain an understanding of the relationship of the kinetics of an activity, pain, and the area of injury (Eillott 1999). In the field of LBP and swimming, the area of interest is the motion and position of the lumbar spine, either during swimming or as a consequence of swimming. The search identified three biomechanical studies exploring the impact of swimming on the spine. The first study analysed the spine during backstroke and breaststroke in recreational swimmers without LBP (Hofling et al. 2002). The rationale for the study was that backstroke is often recommended for people with LBP, but breaststroke is not advised due to the theoretical assumption that lumbar lordosis increases during breaststroke. They found that lordosis is less when swimming than when standing and less when swimming backstroke than breaststroke. The findings demonstrated that although lordosis increases in breaststroke, it does not increase excessively; suggesting that there are no grounds for advising against breaststroke. Another study involving breaststroke was undertaken to identify variants during the stroke associated with LBP (Coleman, Persyn and Winters 2000). Three variants of breaststroke were identified in a group of skilled breaststroke swimmers: a flat variant, keeping the head above the water variant, and an undulating variant. Following stroke analysis of the swimmers with LBP, the researchers found seven abnormal phases in the stroke which could cause LBP. The stroke abnormalities either related to hyperextension in the spine or poor body balance. The study recommended that swimming and health professionals should use biomechanical assessment of the stroke to prevent injuries.

The final study measured three-dimensional movement of the torso during tethered front crawl swimming in college swimmers (Du, Narita and Yanai 2016). The range of extension observed was much less than the available range of spinal movement and there was no difference in the range of torso extension when breathing was added to the stroke cycle. The data from this study led the authors to reject their hypothesis that repetitive hyperextension of the torso in front crawl is a major cause of LBP. People with LBP often have a directional preference to repeated movements of the spine or a spinal posture (Long, May and Fung 2008; May 2011); the findings from these biomechanical studies would be of interest to people with LBP who find their pain is affected by lumbar extension. The studies included in this review considered three swimming strokes: front crawl, backstroke, and breaststroke.

Front crawl and backstroke are predominantly long axis strokes, whereby the body rolls longitudinally (Newsome and Young, 2012, p.61, Swim England 2019, pp.262, 285) whereas breaststroke is a short axis stroke which could impact the lumbar spine due to the body rotating around the horizontal axis (Cole et al. 1997, pp.95-96, Swim England 2019, p.274). Although it is common practice to advise people with poor tolerance of lumbar extension against swimming breaststroke (Dunlap 2009, p.172), the findings from the study by Hofling et al. (2002) suggested that there are no grounds for this advice. The study by Coleman, Persyn and Winters (2000) found that certain methods of swimming breaststroke could have a negative impact on LBP; highlighting that even within strokes there is a great deal of variability in technique which could impact the spine. The study by Du, Narita and Yanai (2016) did not observe hyperextension of the spine during front crawl swimming, but the findings may not be transferable to recreational and older swimmers, who may adopt a different technique due to differences in swimming ability, loss of muscle strength and flexibility. Further biomechanical studies should be carried out to understand more about the impact of the swimming strokes on the spine and LBP, recruiting a combination of skilled swimmers, recreational swimmers, and swimmers with LBP.

2.3.3 Interventional Studies Integrating Swimming into a Rehabilitation Programme for LBP

One systematic review and meta-analysis was identified in the search; the review identified only one RCT evaluating swimming for the treatment of non-specific LBP (Pocovi et al 2022). The double blinded RCT included in the review by Pocovi et al (2022) compared four interventions plus physical therapy: swimming, jogging, backward walking, tai chi, and just physical therapy in retired athletes with chronic LBP (Weifen et al. 2013). The participants in the swimming group were simply advised to take up swimming five days a week for 30 minutes each day for 6-months. The paper did not provide any details of the swimming undertaken, such as which strokes were swum. The study found that swimming was more effective at reducing pain at 3 months and 6 months than no treatment and had better outcomes than jogging and backward walking but had similar changes in the intensity of pain to Tai Chi. Although these findings suggest that swimming could be an effective form of exercise for reducing LBP, the findings may not be transferable to less able swimmers and people who do not have an athletic background. A non-randomised controlled study was

identified in the search, which compared swimming to a control group in females with hyper lumbar lordosis (Manshouri and Rahnama 2014). The swimming programme included backstroke, walking in water and stretches and was delivered for 8-weeks, 3 times a week, for 50-90 minutes each week. The study found there was a significant reduction in lumbar lordosis when compared to the control group, suggesting that if hyper lordosis was a contributing factor to LBP, swimming could be utilised as a modality to modify posture.

Three single arm studies were identified in the review which delivered swimming in addition to other exercise to people with LBP. The first study evaluated a 6-month combined programme of land-based exercise, aquatic exercise, and swimming for people with LBP (Ariyoshi et al. 1999). The aquatic exercise section included stretches, walking, jogging, front, back and side leg raises, bobbing and jumping, and swimming front crawl or backstroke for 25m. This programme was repeated three or four times during the session, once, twice or three times per week for 6-months. There was a significant improvement in the physical scores and swimming ability; 90% of the participants reported that they had improved after completing this programme. The people who undertook the programme 2-3 times a week had a more significant improvement in their physical scores than those who did the programme once a week.

Another study using a more intensive programme of exercise and swimming was undertaken with automotive workers with LBP (Kim, Jung, and Kim 2008). The programme included land-based resistance exercise, a flexibility program for one hour, five times a week, hiking once a week including hills and swimming 40 minutes three times a week. For the swimming section of the programme the participants swam freestyle, swimming 9 repetitions of 50m with a minute between these repetitions. They found no change in body composition, but significantly reduced C reactive protein levels, indicating a reduction in inflammation and improvement in strength and flexibility.

In contrast, the final study identified in the review involved people with chronic LBP in a more controlled environment, trialling a protocol of aquatic exercise and swimming for 40 minutes, twice a week for 12 weeks (Winter and McCauley-Callagy 2002). The programme was designed to improve lumbar stabilisation and strength, and the goals of the session were to decrease pain, increase lumbar mobility and progress the exercises. The exercises included

walking, lower limb exercises, seated exercises, deep water exercises such as jogging, and supine and prone modified swimming. The participants were encouraged to maintain a neutral spine position during the exercises, floats and snorkels were used for the swimming and modified strokes were taught. The study found that activity of daily living scores improved, and pain scores reduced with this exercise programme.

These interventional studies describe heterogeneous treatment programmes which include swimming alongside other exercise and physiotherapy modalities. They illustrate several ways swimming could be integrated into a LBP rehabilitation programme providing some evidence that swimming can be tolerated by people with LBP, alongside aquatic and land-based exercise, and other physiotherapy modalities. A range of outcomes were collected; the studies found that swimming, alongside a multi-modal physiotherapy treatment, resulted in a significant reduction in inflammation and pain, change in posture and improvements in swimming ability, function, strength, and flexibility. Despite these positive outcomes only limited conclusions can be drawn and the findings should be interpreted with caution due to there being a small number of participants and no control group (Gilmartin-Thomas, Liew and Hopper 2018). The swimming component to these programmes varied considerably in intensity from the low-level adaptive swimming programme used by Winter and McCauley-Callagy (2002) to the much higher-level interval freestyle programme used by Kim, Jung, and Kim (2008). Only one study (Winter and McCauley-Callagy 2002) focused on the position of the spine when swimming, encouraging the participants to maintain a neutral spine position, the other studies simply advised swimming. The studies included either front crawl or front crawl and backstroke, this choice could be due to the common view that breaststroke should not be advised to people with LBP (Hofling et al. 2002). The time spent swimming was unclear in the studies which combined swimming with aquatic exercise, however in the other studies the time ranged between 30 and 90 minutes. The frequency of the sessions ranged from once a week to five times a week, with one study finding better outcomes with 2-3 times a week. The information provided in the methods sections of these studies could provide some initial guidance for future research studies involving swimming but should not exclude other protocols being explored.

2.3.4 Limitations

The review did not include research involving adolescent competitive swimmers due to the difference in training volume and the impact of puberty and growth. It is recommended that a second scoping review is undertaken in this age group, as the review had identified one study which found an increased risk of spinal deformity and higher prevalence of LBP in females and another series of case study studies reporting spondylolysis and LBP in adolescent swimmers (Nyska et al. 2000; Zaina et al. 2015).

2.4 Conclusions

The scoping review has confirmed that there is limited research supporting the recommendation of swimming to people with LBP and that observational studies make up the greater proportion of research in this field. The data from the observational studies indicates that swimming is a low-risk form of exercise but not without risk and the findings from biomechanical studies suggest that lumbar lordosis does not increase excessively when swimming breaststroke, backstroke, or front crawl but certain swimming techniques could negatively impact LBP. Interventional trials illustrate that there are various ways to integrate swimming into a rehabilitation programme, providing some initial data on the impact of swimming on LBP and function. The scoping review partly fulfils the MRC developing a complex intervention phase, in that existing interventions have been reviewed and the content of these intervention will guide the research design and the development of the swimming programme. Based upon the content and the gaps in knowledge identified in this scoping review, the methodology chapter which follows will describe how the studies making up this project have been systematically designed to develop and explore the feasibility of a swimming programme as rehabilitation modality for people with CLBP.

Chapter 3: Methodology

3.0 Introduction

Chapter one described the complexity of CLBP, current management approaches and set out the rationale for considering swimming as a rehabilitation modality for people with CLBP. The scoping review in chapter two identified that there was only low-level evidence to support the recommendation of swimming to people with CLBP and confirmed the need for further research on the topic. The Department of Health (DOH) defines research as '*the attempt to derive generalisable new knowledge by addressing clearly defined questions with systematic and rigorous methods'* (DOH 2005, p.3). The methodology chapter will show how the studies which make up this project have been systematically designed to develop new knowledge in the field of swimming, rehabilitation, and CLBP. The chapter describes the scope of the project, the research design and research philosophy underpinning this project. To give context, the background of the researcher is discussed, recognising that she is integral to the design, conduct of the project and interpretation of findings. The chapter will consider each study and discuss and justify the research approach, methodology, research strategy, time horizon, sampling strategy, data collection methods, data analysis methods and ethical considerations. For ease of reference during this chapter the titles of the studies are summarised in Table 7.

Table 7: Study titles

Study number	Title
Study one	Survey of the barriers, enablers, and preferences to swimming for people with CLBP.
Study two	Learning to swim with back pain: A qualitative study of swimmers with CLBP.
Study three	Development of a swimming programme as a rehabilitation modality for people with CLBP using the modified Delphi technique.
Study four	Swimming as a rehabilitation modality for people with CLBP versus routine physiotherapy care: A mixed methods feasibility study.
Meta-inference	Refinement of the swimming programme through the integration and analysis of data from four studies.

3.1 Project aims, objectives, scope, and questions

3.1.1 Aim

To develop and explore the feasibility of a swimming programme as rehabilitation modality for people with CLBP.

3.1.2 Objectives

The gaps in the literature and the theoretical frameworks discussed in chapter one have been used to develop the following research objectives:

- To review the current evidence base supporting to recommendation of swimming to people with LBP.
- To identify the most common barriers, enablers, and preferences to swimming for people with CLBP.
- To explore the experience of swimmers who use swimming to manage CLBP.
- To develop a swimming programme as a rehabilitation modality for people with CLBP, consulting swimming professionals, physiotherapists, and people with CLBP.
- To assess the feasibility of the swimming programme as a rehabilitation modality for people with CLBP.
- To assess the feasibility of conducting a sufficiently powered randomised controlled trial comparing the swimming programme to standard physiotherapy care.
- To combine the data from all four studies and draw meta inferences to enable refinement of the swimming programme.

3.1.3 Scope of Project

The PICO and PIO mnemonics were used to formulate the research questions and to define the scope of the project. P stands for population, problem, or patient; I for intervention or issue; C for comparison; and O for outcome (Huang, Lin and Demner-Fushman 2006). The population of interest for this project were people with CLBP. CLBP is a term used to describe people who have suffered with LBP for more than 3 months (Treede et al. 2015). The intervention focused on the development of a swimming programme as a rehabilitation modality, not aquatic therapy, or aquatic exercise. The comparison was usual physiotherapy

care for people with CLBP. The outcomes of interest were improvements in pain self-efficacy, swimming ability, function, physical activity, quality of life, physical and mental health, weight management and the ongoing use of swimming as a self-management tool. Using these parameters, the following research questions were set for the four studies which make up this PhD thesis.

3.1.4 Research Questions

- What are the most common barriers, enablers, and preferences to swimming for people with CLBP?
- What is the experience of swimmers who use swimming to manage CLBP?
- What is the consensus among stakeholders on how a swimming programme could be delivered as a rehabilitation modality to people with CLBP?
- Can this newly developed swimming programme be delivered as a rehabilitation modality for people with CLBP?
- Are the study procedures feasible for conducting a sufficiently powered randomised controlled trial comparing the swimming programme to standard physiotherapy care?
- What refinements should be considered in the future development of the swimming programme?

3.2 Research Design

Terminology for research design can be confusing due to there being several categorisation methods. The design can be categorised by time, for example prospective, retrospective, cross-sectional or longitudinal, by the usability of the findings, basic or applied, by the role of the researcher, interventional or observational or by the methods used, for example survey, case study or experimental (Thiese 2014). The research onion provides a schematic representation of the research design process (Saunders, Lewis, and Thornhill 2019), this model will guide the methodology chapter. The model recommends that the outer most layer of the research onion, research philosophy is considered first, followed by the research approach, methodological choice, research strategies, time horizon and lastly techniques and procedures including sampling strategies, data collection methods and data analysis. This process ensures that research design choices are well reasoned, and the scope and context of the project are transparent. Figure 8 illustrates how this project maps onto the research onion and Table 8 provides a summary of the research design.

Choices regarding the research design for this project are underpinned by the recognition that CLBP is a complex multi-dimensional condition and rehabilitation is a complex intervention. The findings from the literature review, the key uncertainties, the COM-B and BCW analysis (Michie, Atkins and West 2014), current swimming learn-to-swim frameworks and the gaps in service provision and have been considered during the design of this project (STA 2023; Swim England 2023). The MRC framework, a recommended framework for healthcare professionals conducting research for complex interventions, has also provided a conceptual framework guiding the research design (Campbell et el. 2000, Skivington et al. 2021). The framework, which was discussed in chapter one, helps researchers identify the location of the project on the research pathway. The analysis in the introduction chapter identified that the project should sit in the feasibility phase. The core elements to be considered were stakeholder engagement, key uncertainties, the context of the swimming programme, programme theory and intervention refinement.

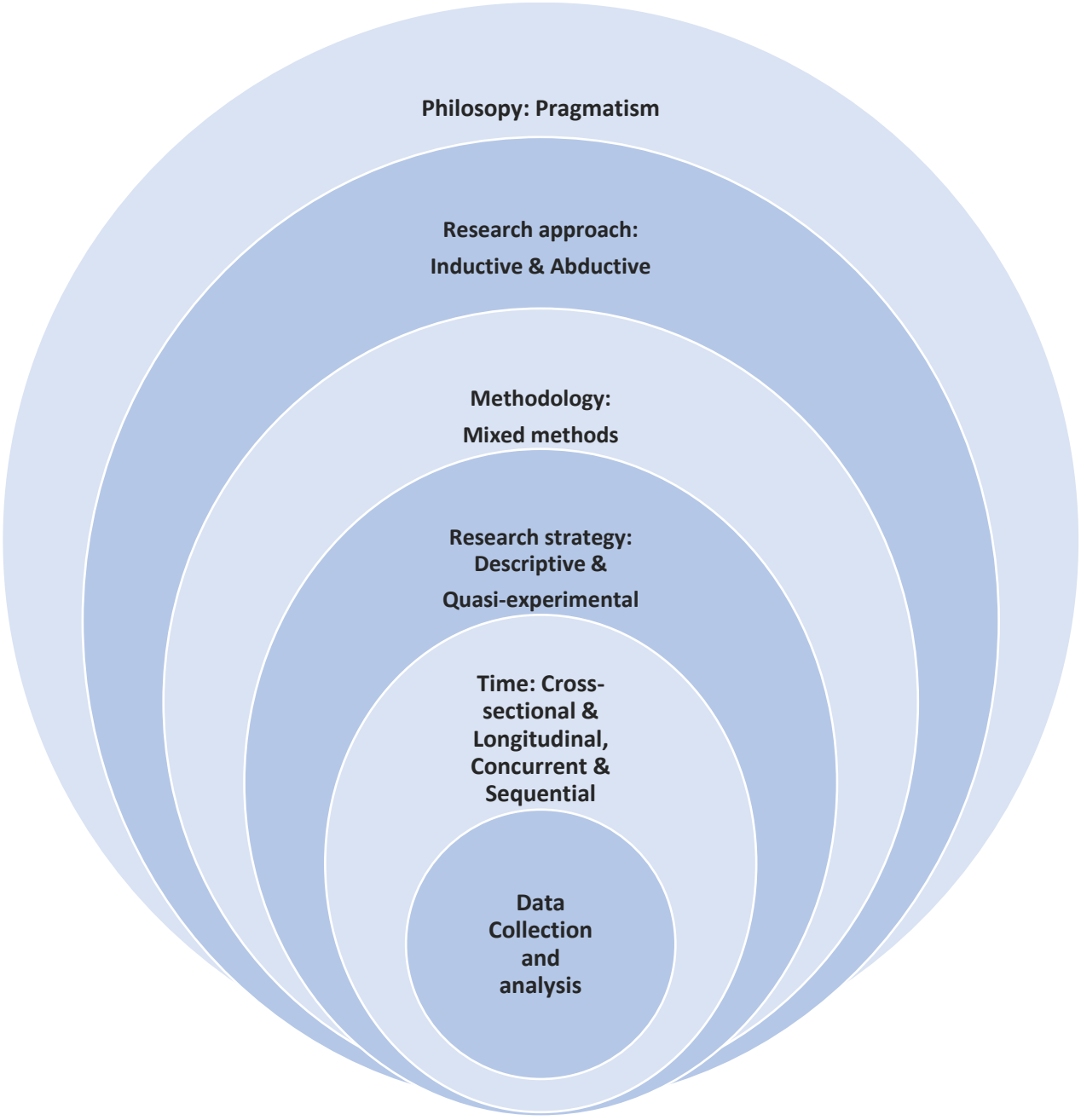

Figure 8: Project mapped onto the Research Onion (Saunders, Lewis, and Thornhill 2019)

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Table 8: Summary of research design for each study

	Study one	Study two	Study three	Study four	Meta-inference
Title	Survey of the barriers, enablers, and preferences to swimming for people with CLBP	Learning to swim with back pain: A qualitative study of swimmers with CLBP	Development of a swimming programme as a rehabilitation modality for people with CLBP using the modified Delphi technique	Swimming as a rehabilitation modality for people with CLBP versus routine physiotherapy care: A mixed methods feasibility study	Refinement of the swimming programme through the integration and analysis of data from four studies
Research approach	Exploratory Abductive reasoning	Exploratory Inductive and abductive reasoning	Exploratory and confirmatory Inductive and abductive reasoning	Exploratory and confirmatory Inductive and abductive reasoning	Abductive reasoning
Methodology	Quantitative	Qualitative	Mixed methods	Multi-methods	Mixed methods
Research strategy	Descriptive	Descriptive	Descriptive	Descriptive and Quasi-experimental	
Time horizon	Cross-sectional	Cross-sectional	Longitudinal	Longitudinal	
Sampling strategies	Purposive	Purposive	Purposive	Non-probability	
Data collection	Questionnaire	Interviews	Questionnaires	Questionnaires and field notes	Questionnaires, interviews, and field notes
Data analysis	Descriptive statistics	Thematic analysis	Descriptive statistics Thematic analysis	Descriptive statistics Thematic analysis	Meta-inference

3.3 Research Philosophy

Philosophical assumptions and worldviews or paradigms impact how researchers conduct and report research; ontology, epistemology, axiology, and methodology are worldview elements which should be acknowledged when undertaking research (Creswell and Clark 2007). Pragmatism is the most common research paradigm used for mixed methods research (Dolan, Nowell and McCaffrey 2022; Mayumi and Ota 2023). Pragmatism originated in the late 19th century through the work of Dewy, James, Rorty, Haack and Pierce (Bacon 2012; Long, McDermott and Meadows 2018). Although there were a wide range of views within this group of pragmatists, they held a common view that enquiry should start from our current practices and beliefs and attempts to define what makes beliefs or statements true prior to enquiry should be rejected (Mayumi and Ota 2023). The pragmatists argued that perfect knowledge was not required and not possible; instead, they judged the value of knowledge by its context and ability to address practical questions (Long, McDermott and Meadows 2018). Epistemology considers the relationship between the researcher and the research; for pragmatism data is collected by '*what works'* to answer a research question (Creswell and Clark 2007; Mayumi and Ota 2023). Pragmatists reason that experience is required to attribute meaning to an event and rather than using absolute truths pragmatic research uses experience to build knowledge (Allemang, Sitter, and Dimitropoulos 2022; Bacon 2012). Pragmatism is problem centred and orientated to real-world practice (Creswell and Clark 2007), which makes it a useful paradigm when researching complex interventions such as rehabilitation. It has been said that physiotherapy practice aligns itself with the research paradigm of pragmatism and mixed methods research (Shaw, Connelly, and Zecevic 2010); in clinical practice physiotherapists are guided by both facts and principles when assessing and treating patients.

William James published a series of essays on pragmatism in 1907 which discuss the philosophy and core concepts of pragmatism including plurality, subjectivity, truth, fallibilism and meliorism (Dolan, Nowell and McCaffrey 2022; James 1907). In the series of essays James explained how empiricists are guided by facts, their traits included being sensationalist, sceptical, pluralistic, fatalistic, pessimistic, and materialistic. Rationalists are guided by principles and abstract matters, in contrast to the empiricists their traits included being

intellectualistic, dogmatical, monistic, free-willist, optimistic, and idealistic (James 1907). The pragmatist view was that the world requires both facts and principles and that they should adopt a middle ground or be a mediator between the traits of both empiricists and rationalists (James 1907). Pragmatism acknowledges the real world of personal experience, in which there are many interwoven, confusing, and unclear experiences (James 1907). Axiology refers to values, pragmatism considers both bias and unbiased perspectives (Creswell and Clark 2007). Pragmatists use both logic and senses and will consider all personal experience; they use what works best for the question that they wish to answer. (James 1907). A pragmatist would ask, what difference would it practically make to anyone if this idea or another idea were true, they recognise if there is no practical significance then there is no value in the question (James, 1907). Ontology refers to the nature of reality (Creswell and Clark 2007), pragmatists deal with facts, but also recognise that there are multiple truths (James, 1907); truth is considered a verification process (James, 1907) and truth is made out of previous truths (James, 1907).

How does this project align with the core pragmatist concepts of plurality, subjectivity, truth, fallibilism and meliorism (Dolan, Nowell and McCaffrey 2022; James 1907)? Doctoral studies are usually undertaken due to the belief that the world can be improved through human effort; this is what is meant by the concept of meliorism (James, 1907). The rationale for undertaking this research project was to reduce health inequalities and explore and develop a new rehabilitation modality for people with CLBP. People with CLBP, the target population for this project, often have a wide range of symptoms, problems, and functional limitations, equally rehabilitation and exercise has multiple methods, targets, and outcomes. Plurality refers to multiple; within the philosophy of pragmatism this can refer to multiple theories, ideas, and realities; a concept which aligns both with the target population and intervention. The project has used research methods to explore and develop a new rehabilitation modality building on what is already known. However, although new truths can be discovered, pragmatists recognise that new truths are provisional and that there are multiple truths. This was recognised during the meta inference chapter, which looked at refining the intervention and in the conclusions chapter, which recommended areas for future work in the field. Various stakeholders have been involved in this project, recognising the concept of subjectivity, not being able to see all realities. The discussion sections in the study chapters

align with the concept of fallibilism, which refers to the idea that no truth can be absolutely proven (Dolan, Nowell and McCaffrey 2022), the findings from these projects will add to what is known in the field but does not purport to prove efficacy. The research aim and questions from this project have practical significance not only to people with CLBP but also physiotherapists, health, and swimming professionals.

3.4 About the Researcher: Beliefs and Assumptions

The researcher is an Advanced Practice Physiotherapist who has a special interest in the assessment and management of patients with CLBP. In her spare time, she swims with a master's club competitively, in the pool and outdoors in the sea or lake. She is a Level 2 swimming coach and has volunteered with her local swimming club for the last 10 years. The researcher is able to swim all four strokes; the furthest distance she has swum without stopping is 11 miles, the length of Lake Windermere. She is aware how fortunate she is that she learned to swim as a child, that she can swim well. She feels that her health has benefitted from swimming; she does not suffer from CLBP or any other long-term condition but has experienced short periods of LBP. Working for an acute NHS trust, the author agrees that exercise and tools to enable self-management should be an integral component of all NHS CLBP rehabilitation programs. She recognises that people with CLBP have more limited exercise options but had noticed the value when people are able to be active with CLBP. The author is often frustrated and saddened by the lack of funding for rehabilitation for people with CLBP, particularly for those who are unable to work and afford to pay for a leisure centre membership. People are often trapped in a vicious cycle of being unable to afford to exercise and therefore struggle to return to work. She hopes that with more research in this field, more funding will be directed to support this population, thereby reducing health inequalities.

The researcher recognises that her life experience and worldviews have directed the development and execution of the project; other researchers could have tackled the same problem in a different manner. One area is the way that swimming is taught, delivered, and practiced. Being a competitive swimmer, the researcher recognises that having a good swimming technique makes traveling through the water more enjoyable and results in less

strain on the body. Therefore, it is the researcher's view that people with CLBP should be given the opportunity to learn how to improve their swimming technique. The researcher has reflected during the different stages of the project whether the study findings match her expectations or whether swimming using any technique is beneficial. The research approach used for this project has developed partly due to her experience both in the pool as a swimmer and in the clinic working with people with CLBP. She hopes in the future to see more people with CLBP in the pool and less people returning to clinic. The researcher's world view aligns with core concepts of pragmatism, recognising that there are multiple realities and truths and that truths are only provisional; research is an ongoing cyclical process. The researcher also agrees that due to subjectivity, all stakeholders should be involved in the research process, enabling research to have real world practical impact.

3.5 Research Approach

The two contrasting paradigms in research are positivism and interpretivism. Positivism involves quantitative methods which are based upon the scientific method, in contrast interpretivism acknowledges that research is subjective, using qualitative methods where researchers aim to gain an understanding of a phenomena's subjective meaning and individuals experience (Allsop, 2013). The positivism paradigm usually takes a deductive, confirmatory approach and the interpretivist paradigm an inductive, exploratory approach. There are advantages and limitations to both paradigms, the choice of paradigm will depend on many factors including the philosophical stance of the researcher, the research question, the gaps in knowledge in the field and the aims and intended impact of the research. Examples of health research undertaken in the positivist paradigm include biomedical and biomechanical research and RCTs whereas the interpretivist paradigm uses methods such as interviews and focus groups, using language instead of numbers as data. Pragmatism sits between these two paradigms, utilising deductive, inductive and / or abductive reasoning and quantitative, qualitative and / or mixed methods. Deduction, induction, and abduction describe different forms of reasoning (Lipscomb 2012). A deductive research approach develops a hypothesis based upon existing theory, collects and analyses data to support or reject the hypothesis and an inductive approach collects data, looks for patterns and develops

theory. Abductive reasoning is making a fair guess from the current evidence and the information that is known (Lipscomb 2012; Merriam Webster 2023). Abductive reasoning usually comes at the first stage of scientific enquiry, it requires creative insight linking new data to existing theory and knowledge (Raholm 2010).

The introduction chapter and scoping review highlighted that there was limited published research whereby swimming had been used as a rehabilitation modality for CLBP and no specific swimming frameworks or guidelines for this population. It was recognised that there are several ways swimming could be delivered to people with CLBP and many methods of integrating swimming with other rehabilitation tools. With this knowledge it would be difficult to justify conducting the research solely within the positivist paradigm using deductive reasoning. A deductive approach would have evaluated whether swimming or a swimming programme was equal or superior to current rehabilitation modalities, however, it was not known which method of delivering swimming should be evaluated. The aim of the research project was to develop a swimming programme for people with CLBP, the outcome could be a new rehabilitation modality for people with CLBP. Both exploratory and confirmatory research would be required to address this aim, therefore, research could not be undertaken in a purely interpretivist paradigm using inductive reasoning. Qualitative approaches generate theories; however, the findings are not generalisable to a population due to the low sample size and methods of data collection and analysis. Based on the aims and the intended outcome and impact, this project was designed within the pragmatist paradigm utilising inductive and abductive reasoning.

The first study took an exploratory research approach, using a questionnaire to identify the determinants to swimming for people with CLBP. The rationale behind this approach was that prior research had identified some of the barriers, enablers, and preferences in the general population to swimming and in the chronic pain population to exercise, physical activity, and aquatic exercise (Boutevillain et al. 2017; Fisken et al. 2016; Joelsson et al. 2017; McPhail et al. 2014). The inference for this study was that there are many determinants impacting uptake and engagement in swimming, people with CLBP may have their own unique set of barriers, enablers, and preferences but some are more common. Given that the aim of the study was to develop a swimming programme to be delivered to a group of people with CLBP, it would be worthwhile identifying the most common determinants in this population and map them

onto the COM-B model. This would not preclude recognition and discussion about individual barriers, enablers, and preferences, but it would allow the most popular determinants to be targeted in a group setting. Abductive reasoning was employed when mapping the determinants onto the COM-B model to enable a better understanding of the nature of the determinants.

The second study also adopted an exploratory approach, using semi-structured interviews to explore the experience of swimmers who use swimming to manage CLBP. Aside to testimonials (Swim England 2019), no research had been undertaken exploring the experience of people who use swimming to manage CLBP. The rationale behind this study was that it is known that some people with CLBP swim (Baptistia et al. 2020; Setchell et al. 2019) and that swimming is also recommended to this population by health professionals and via public health information (Ribaud et al. 2013; Versus Arthritis 2022). It was inferred that the knowledge gained from learning and synthesising the lived experience of people using swimming in this manner would increase the body of knowledge in this field and would be of value when developing the swimming programme in study three. Inductive reasoning was utilised as no research had been conducted in this field. Abductive reasoning was employed when mapping the subthemes onto the COM-B model enabling a better understanding of the behavioural components of these subthemes.

The third study took both exploratory and confirmatory approach using a modified version of the Delphi technique; there were several reasons for taking this approach. First and foremost, it was recognised that exploring and utilising the knowledge and experience of people with CLBP, swimming professionals and physiotherapists when developing the swimming programme could improve the usability and acceptability of the intervention. The process of developing a group consensus, using methods such as the Delphi technique, assumes that judgements and guidelines developed as a group will be greater than those developed by one individual (Rowe, Wright, and Bolger 1991). It could also be suggested that this approach would enable these stakeholders to develop further knowledge, through the participant feedback provided at each stage of the survey. Finally, it was recognised that a confirmatory approach in the second and third rounds of the survey would enable the participants to agree on a swimming programme, this programme could then be trialled in study four. The findings from the first-round exploratory survey were analysed using inductive reasoning. The

approach was modified in that the data from the first-round survey, study one and study two was combined and analysed using abductive reasoning. The rationale behind this modification and combining data from three studies involving multiple stakeholders was that it would enable a greater range of experiences and expertise to inform the development of the swimming programme. The second part of the study, after the second and third round surveys, did not employ a specific form of reasoning as it did not aim to test a hypothesis or to develop theory, it aimed to generate guidelines for a swimming programme. Abductive reasoning was employed when mapping the sections of the programme onto the COM-B model and BCW enabling a better understanding of the behaviour components and interventions.

The fourth study also took an exploratory and confirmatory approach, testing the feasibility of the swimming programme as a rehabilitation modality for people with CLBP, assessing the feasibility of conducting a sufficiently powered randomised controlled trial (RCT) comparing the swimming programme to standard physiotherapy care and collecting data to guide refinement of the swimming programme. The rationale behind this approach was that the swimming programme was newly developed, and it was anticipated that it would require further development and refinement. It was recognised that it was too soon to proceed to a full RCT, and it would be good practice to test the trial procedures and the swimming programme first in small scale (Morgan et al. 2018). Qualitative and quantitative data was collected to guide whether the swimming programme and the trial procedures would need to be modified before designing a large RCT in the future. Inductive and abductive reasoning was utilised in the analysis of the questionnaire and observational data; no hypothesis had been set so deductive reasoning was not utilised. Abductive reasoning was utilised during the integration and analysis of the data from all four studies and the mapping of the sections of the programme onto the COM-B model and BCW in the meta inference chapter.

3.6 Methodology

The terms research methodology and research methods are sometimes used interchangeably. The National Institute for Health and Care Research (NIHR) define the term methodology as *'how research is done, it covers how information is collected and analysed as well as why a particular method has been chosen'* (NIHR, 2023). Research methods refers to the data collection techniques for example observation, questionnaire, interview, or experiment (Saks and Allsop 2013). The methodology for this project was Mixed Methods. Mixed Methods research, however, is both a methodology and a method of inquiry, as a methodology it involves the '*philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches'* (Creswell and Clark 2007, p. 5). As a method qualitative and quantitative data is collected and analysed together in a study or series of studies, enabling a more holistic understanding of the research question than if one approach had been taken (Creswell and Clark 2007; Hansen et al. 2016). The rationale for choosing this methodology was that this was a complex research problem, the MRC framework recommends using mixed methods when researching complex interventions (Skivington et al. 2021). The scoping review had identified limited research in the field and the MRC framework analysis had suggested a developmental and feasibility research design. Therefore, the project utilised both quantitative and qualitative research methods. Mixed methods research, however, involves more than simply collecting qualitative and quantitative data, the data should be combined and integrated during the research process, providing a more complete analysis (Creswell, Fetter and Ivankova 2004). Meta-inference is a recommended technique when conducting mixed methods research, it is defined as *'the theoretical statements, narratives, or a study inferred from an integration of findings from quantitative and qualitative strands of mixed methods research'* (Venkatesh et al. 2013, p.38). The project included the combining of study data and meta-inference at two stages: during study three and after study four.

Mixed methods research draws on both the positivist and interpretivist paradigm and is often underpinned by the philosophy of pragmatism. There are several mixed methods designs, they are named by purpose; exploratory or explanatory, by timing of study; sequential or concurrent and can be weighted based upon the study approach; qualitative or quantitative (Creswell and Clark 2007; Vedel et al, 2019). The project design had two phases, the first

phase would be termed a convergent exploratory design and the second phase a sequential exploratory design. The first phase included a greater proportion of qualitative data and the second phase the weighting was slightly greater for quantitative data. Quantitative data from study one, qualitative data from study two and qualitative data from the round one survey from study three were used to build the quantitative survey of the second round of study three. Study one and two were run concurrently and round one of study three occurred at a later point due to workload and timings of the studies. The round one survey, however had been constructed prior to study one and two so the findings from study one and two did not influence the questions asked in study three. In the second phase the quantitative data collected in the round two and three surveys from study three supported the swimming programme to be trialled in study four whereby quantitative and qualitative data would be collected. Figure 9 shows the relationship between the studies and the methodology.

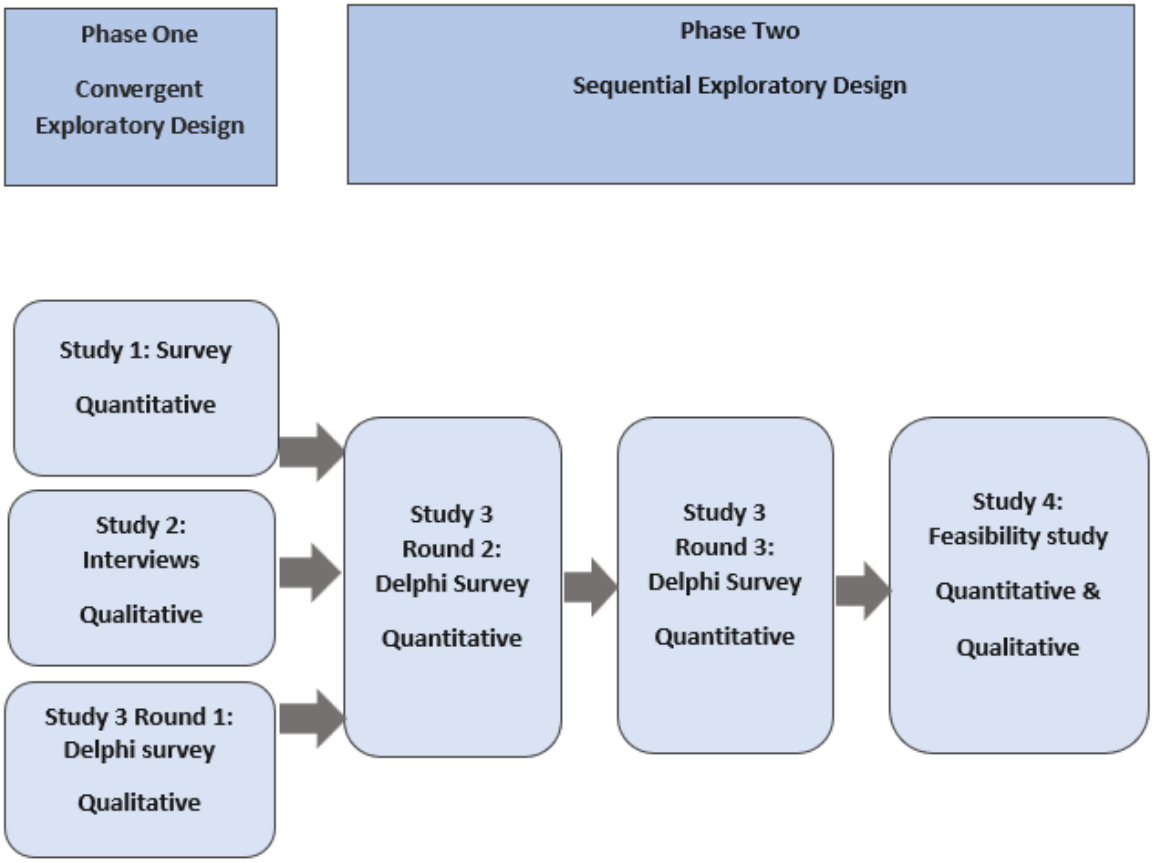

Figure 9: Mixed methods flow chart

3.7 Research Strategy

The project was conducted through four studies employing two research strategies. Study one, two and three employed a descriptive research strategy, conducting exploratory research using questionnaires and interviews. Descriptive research describes the characteristics of populations and conditions; it does not aim to manipulate variables or test a hypothesis (Siedlecki 2020). The aim of conducting the survey in study one was to collect data to gain a better understanding of the most common barriers, enablers, and preferences to swimming in this population. The interviews in study two aimed to gain an understanding of the lived experience of swimmers who use swimming to management CLBP. The modified Delphi study undertaken in study three also took a descriptive research strategy; surveying people with CLBP, physiotherapists, and swimming professionals in order to gain a consensus on how a swimming programme could be delivered to people with CLBP. The data generated from study one and two was integrated with the data from study three during the development of the swimming programme in study three.

Study four, a feasibility study, employed both descriptive and quasi-experimental research strategies, asking whether a swimming programme could be delivered as a rehabilitation modality to people with CLBP. Unlike an experimental research strategy, a quasi-experimental research strategy does not randomise participants (Andrade et al. 2021), in the case of this study this was due to issues relating to feasibility of the study procedures and pool availability. The experimental strategies included providing an intervention and comparing outcomes between intervention groups. The descriptive strategies included collecting observational and questionnaire data to help refine and develop the study procedures and the swimming programme.

3.8 Time Horizon

Time horizon refers to whether the data was collected from one point of time or at multiple time points; cross-sectional studies collect data at one point of time and longitudinal studies data collect data at multiple time points (Caruana et al. 2015). Time horizon in the context of mixed methods also refers to whether the studies are sequential or concurrent (Creswell and Clark 2007). Study one and two were run concurrently; this was done partly due to time management reasons, the data had to be collected in a timely manner in order that the PhD deadlines were met. Secondly findings from study one would not impact or inform the conduct of study two and vice versa. Study one and two (together), study three and study four were sequential; the data was collected at different time points. The rationale behind choosing this sequential design related to the research project aim, which was to develop a swimming programme. The findings from study one and two were used to guide the second questionnaire in study three and the findings from study three were used to guide study four, see Figure 10 for project flow chart.

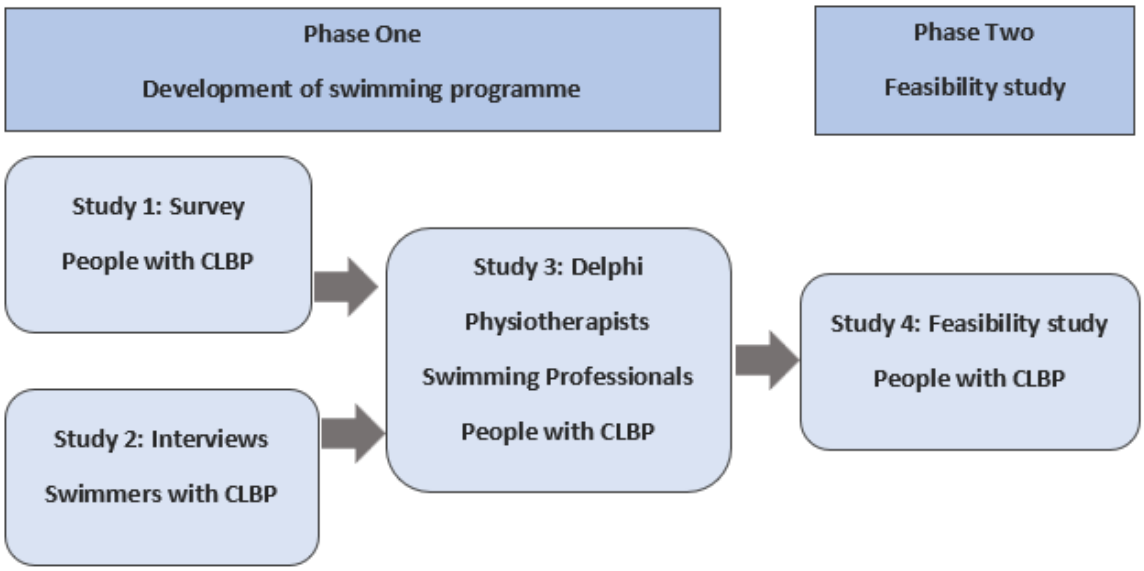

Figure 10: Project flow chart

Study one and two were cross-sectional studies. Study one aimed to explore the most common barriers, enablers, and preferences to swimming for people with CLBP at one period of time. It was recognised that these determinants could vary week to week and over the course of a year for some people. The aim of the research question, however, was not to

explore the change in these determinants, it was merely to gain an understanding of those factors at that point of time. Similar studies surveying barriers in people with LBP have also taken a cross-sectional approach (Schaller et al. 2017). Study two aimed to explore the experience of people who use swimming to manage CLBP, again data was collected from one time period. It was recognised that over the course of someone's life, experience will continue to develop, week by week. The aim of the research was not to explore how the experience developed and changed but to explore the experience of people at that particular moment in time. Similar studies exploring the experience of people with CLBP have also taken a cross-sectional approach (Osborne et al. 2014).

Study three and four were longitudinal studies. Study three utilised three rounds of surveys; the purpose of the Delphi study was to develop a consensus within the group, this was a longitudinal process and could not be achieved by collecting data during one time period. The swimming programme delivered in study four was run over six sessions over three weeks and data was collected at the start of the study, on completion of the swimming programme and 6-months later. The study aimed to evaluate the swimming programme as a rehabilitation modality, one outcome of interest was whether the participants were still swimming 6-months later. For this reason, data was collected 6-months after completion of the programme. Similar trials involving rehabilitation for CLBP have also taken a longitudinal approach, recognising that short-term findings may not translate to long-term outcomes (Garcia et al. 2022; Kent et al. 2023).

The context of the time period was considered in the discussion for all studies, recognising that at other time periods the findings may be different. One significant factor was that the studies were conducted between July 2020 and September 2022 when the COVID-19 measures were in place to varying degrees. Conducting the studies during another time period may have yielded different results. The practical constraints of conducting the studies is known to influence on the time horizon for the studies. A PhD has a timeline the researcher must follow, it is difficult for researchers to incorporate too many longitudinal studies during a PhD. This factor had some bearing on the decision as to how many time points to collect the data.

3.9 Sampling Strategies

Sampling strategies refers to who the data will be collected from, the type of sampling approach and how many participants took part in the studies (Saunders, Lewis, and Thornhill 2019). The research project employed a purposive sampling strategy recruiting the following stakeholders for this project; people with CLBP, physiotherapists, and swimming professionals. The overall sampling strategy for the project was concurrent not sequential, meaning that the sampling strategy from one study did not inform the strategy in another study (Venkatesh, Brown, and Sullivan 2016). The inclusion criteria for the people with CLBP in each study was that they should have experienced LBP for more than 3 months, be aged 18 years or older and be able to speak and read English. The reason for setting this criterion was that CLBP has been defined as having LBP for more than 3-months (Treede et al. 2015). The project was aimed at adults, guidelines state that research should only include children if comparable research can't be conducted with adults to answer the same question (McIntosh et al. 2000). Translators could have been employed to allow people who cannot speak English to take part however due to financial restrictions this was not possible.

Studies one, three and four recruited people with CLBP from physiotherapy and orthopaedic outpatient clinics at East Kent Hospitals University NHS Foundation Trust (EKHUFT) and studies two and three recruited via social media. This recruitment strategy aligned with each of the study aims. Study one aimed to identify the most common barriers, enablers, and preferences to swimming, it was deemed that current patients seeking physiotherapy care for CLBP would be more likely to encounter barriers to exercise and swimming. In contrast in study two the aim was to explore the experience of swimmers who use swimming to manage CLBP. It was recognised that the experience of this group of '*expert patients*' who were not currently seeking NHS care for CLBP would provide a different perspective to those in study one and this could be of value when developing the swimming programme (Cordier 2014; Tattersall 2002). As study four was interventional it was more appropriate to recruit current NHS patients with CLBP as this was the target population for the intervention. The project as a whole used a different cohort of people with CLBP for each study, following recommendation from the ethics committee to reduce participant burden.

Study three recruited a combination of current patients and people not seeking care for CLBP, this was appropriate as one of the key inclusions was that they should have an interest in swimming, not that they were seeking care. Social media was used to recruit physiotherapists qualified for more than 5 years, with a special interest in CLBP, and experienced swimming teachers or swimming coaches, qualified for more than 5 years, with experience teaching or coaching adults to swim. This criterion was chosen to ensure levels of expertise. An expert has been defined as '*someone with knowledge and experience specific to the research problem, it is acknowledged that it is difficult to measure expertise quantitatively*' (Nasa, Jain and Juneja 2021, p.118). Qualifications and time working in the field was used in this study as a measure of expertise; whilst recognising this approach has limitations this is a common strategy taken with most Delphi studies (De Villiers, De Villiers and Kent 2005; Taylor 2019).

The intention with study four was to use simple random sampling, a probability sampling technique to allocate them to an intervention (Elfil and Negida 2017; Vadakedath and Kandi 2023). However due to the PhD timeline and limited time when the pool could be hired non-probability convenience sampling was used, whereby people could take part in the swimming arm of the study if they were available for the pool times (Elfil and Negida 2017; Vadakedath and Kandi 2023). This pragmatic approach reflected usual clinical practice in that those who were available to attend and wished to try the swimming programmes were allocated to the swimming arm and those who could not were offered the physiotherapy arm. It was recognised that if there were unlimited resources NHS patients would not need to choose in this manner and in a definitive RCT, a wide range of pool times would need to be offered to overcome this barrier. This choice of sampling also reflected the objectives of the study, which were to evaluate whether the swimming programme and trial procedures were feasible, not to generalise the findings to the general population. The rationale underpinning the sample sizes for each study will be discussed in the study chapters.

3.10 Data Collection Methods

Data collection is the process and methods used to systematically collect data to answer a research question, evaluate outcomes, or to test a hypothesis (Totten et al. 2020). It is common practice in research involving rehabilitation to use a variety of methods of data collection (Lamb et al. 2010; Puerto Valencia et al. 2021). This research project collected data using semi-structured interviews, questionnaires, and observational field notes. Semi-structured interviews are a common method to collect qualitative data, they allow the researcher to guide the interview but allow scope for in-depth discussion of a wide range of topics (Jamshed 2014). In study two semi-structured interviews, using an interview guide, were conducted to explore the experience of swimmers who use swimming to manage CLBP. The interview guide enabled the swimmers to discuss their experience but allowed the researcher to guide discussion to ensure that specific topics related to the development of the swimming programme were covered. As recommended in the MRC framework, the core element of context was considered and disclosed. For example, the location of the interviews for study two had to adhere with the COVID-19 measures; the interviews were conducted in-person outdoors, via video conference platform or telephone. Collecting data through semi-structured interviews aligned with the pragmatic concepts of plurality and subjectivity; recognising that there are multiple realities in this field, and it is not possible to see all realities.

Questionnaires are another common data collection method used in descriptive research; they can be used to gain a better understanding of the views and experience of a section of a population, enabling a large sample to be surveyed and are low cost to run (Safdar et al. 2016). On-line questionnaires were used to collect data in study one, three and four. Three of the questionnaires used in study four were common validated outcome measures used in CLBP research. These outcomes questionnaires were chosen to reflect those commonly used in CLBP research and to measure outcome pertinent to rehabilitation and the swimming programme objectives (Froud et al. 2016; Garratt, et al. 2021; Lochting et al. 2017; Maughan and Lewis 2010). The questionnaire designed for study one was based upon the literature review and the COM-B analysis, building on what was known from existing truths, i.e., barriers already known, to develop new truths, barriers in the CLBP population (Boutevillain et al.

2017, Joelsson et al. 2017, McPhail et al. 2014); a five option Likert scale was used recognising the pragmatic concept of plurality. The three questionnaires used to collect data in study three were developed based upon the Swim England and STA lesson plans (STA 2023, Swim England 2023), the ATACP guidelines for delivering aquatic therapy (ATACP 2021) and the COM-B and BCW analysis completed in chapter one. Qualitative data was collected via the first-round questionnaire and quantitative data, using the Likert scale via the second and third-round questionnaires. Data collection in a Delphi study is sequential, the data analysis from the first-round questionnaire guides the development of the second-round questionnaire and the analysis from the second-round questionnaire guides the development of the third-round questionnaire (Jones and Hunter 1995).

Three questionnaires were developed in study three to collect quantitative data from the participants prior to starting the swimming programme in study four. The questionnaires asked about swimming ability, CLBP, and general health to ensure the safety of the participants during the trial and to minimise the risk of adverse events. The process used in study three to develop the questionnaires allowed for stakeholders to make suggestions for the content and to agree on the final version. In study four a follow up participant feedback questionnaire also collected quantitative and qualitative data to assess the feasibility of the swimming programme as a rehabilitation modality for CLBP and to guide the refinement of the swimming programme.

Observational data was recorded on the session plans by the researcher and swimming teacher to enable assessment of the feasibility of the study procedures, the feasibility of the swimming programme as a rehabilitation modality for people with CLBP and to guide the refinement of the swimming programme. It was recognised that this was the first time this newly developed swimming programme had been trialled, supporting the need to collect this qualitative observational data. Quantitative data concerning recruitment rate, recruitment time, availability, equity to access to treatment in the comparison group, retention rates, incomplete data and safety data was collected through administrative data by the researcher and recorded in the research files to assess the feasibility of the study procedures. These are common sources of data collected in feasibility trials, enabling modifications to be made prior to conducting a large clinical trial (Bowen et al. 2009). The data collected in this research project fulfilled many of the MRC framework core elements; the stakeholders who would use

or deliver this swimming programme were consulted, the context where the swimming programme could be offered was considered, key uncertainties when delivering swimming to people with CLBP were explored and the data was collected to refine the intervention.

3.11 Data Analysis Methods

Qualitative data analysis methods were employed in study two, three, four and the meta inference chapter and quantitative data analysis methods in study one, three and four. Thematic analysis, a qualitative data analysis method, was used to analyse the interview data from study one, the round one questionnaire data from study three and the questionnaire and observational data from study four. Thematic analysis has been defined as '*method for identifying, analysing and reporting patterns within the data'* (Braun and Clarke 2006 p.79). It is recognised that unlike quantitative techniques when using thematic analysis, the researchers are the instrument for the data analysis (Nowell et al. 2017). To improve transparency and credibility, the thematic analysis process should be well documented and to provide context, a reflexivity statement should be included (Peddle 2022). The rationale behind using thematic analysis for this research project was that the literature review had identified limited research supporting the recommendation of swimming to people with CLBP. It has been recognised that thematic analysis is not only a valuable tool when summarising key findings from large quantities of written data, but it can also be used to generate anticipated insights (Nowell et al. 2017). This method of data analysis aligned with the understanding that this research problem was complex and swimming as a rehabilitation tool was likely to be a modality that had multi-dimensional effects. It was recognised that for this topic it was important to not only explore known truths but also to identify new truths.

Descriptive statistics were used to analyse the questionnaire data from study one, the questionnaire data from the second phase of study three, the research file and questionnaire data from study four. The purpose of descriptive statistics is to summarise data in a meaningful and logical way (Vetter 2017). The data for the studies was analysed and presented as percentages, mean, median, standard deviation (SD), interquartile range (IQR). The rationale behind the choice of statistics for each study aligned to the study aims and the research strategy. The research strategy for study one and three was descriptive and for study four

descriptive and quasi-experimental. Inferential statistics were not required as none of the studies had been designed to test a hypothesis. The choice of statistics enabled the findings to be shared in a clear and concise manner.

The project involved the combining and analysis of qualitative and quantitative data from different studies during study three and after study four. The integration of findings was based on the process described by Skamagki et al. (2022), Guetterman, Creswell, and Fetters (2015) and Fetters, Curry, and Creswell (2013). The authors recommend using joint display tables which enable organisation and analysis of mixed methods datasets. It has been proposed that there are four methods of data integration; connection of phases, comparison of results, assimilation of data and emerging strategies (Pluye et al. 2018). The types of integration used in this project were comparison of findings and assimilation of data. The data was assessed as to whether the findings were congruent, diverged or whether new insights were observed. The purpose of combining the data during two stages of the project was to allow the experience of multiple stakeholders to guide the development and refinement of the swimming programme, aligning with the pragmatic concept of subjectivity. Further information regarding the data analysis is included in the study chapters.

3.12 Ethical Considerations

The research project received ethical approval on the 22nd of April 2020 from the Queen Square Research Ethics Committee: REC/LO/0397; see Appendix A. Due to the project including an interventional feasibility study the project underwent a full ethical review. There are many ethical principles to consider when conducting healthcare research; these are guided by the principles set out by in the Declaration of Helsinki in 1964 (World Medical Association 2023). The research should be essential and in the public interest, this principle was addressed when writing the rationale for the study, when reviewing the literature and through peer and ethical review of the study protocol. Participants have the right to informed consent, they should be informed of the risks and the benefits and be aware that they can withdraw their consent at any point without reason, this information was clearly stated on the participant information sheets and consent forms and discussed during the consent process. Participants should be made aware of the risks and have access to compensation if an adverse incident should arise, this was available through insurance provided by the sponsor. Data protection and confidentiality was another consideration, the paper research files were kept in a secure location at the hospital, the computer files were password protected and the data was anonymised with a participant number. In order to reduce level of risk to the participants, the researcher and swimming professional, a risk assessment was undertaken, and any adverse events were recorded, reviewed, and actioned. The researcher has extensive experience working with people with CLBP, the programme was delivered in a small group, time was spent at the beginning of each session checking if there were any adverse effects from the last session thereby minimising the risk of flare ups. Using an external site, a leisure centre, posed additional risk, therefore the centre risk assessment was reviewed, and precautions were taken due to the risk of being in a pool environment. All sections of the population should be able to take part in research (NIHR 2022a). The project was awarded grants from the Musculoskeletal Association of Chartered Physiotherapists and East Kent Hospitals University NHS Foundation Trust. The funding for this project enabled thank you vouchers to be sent to participants in study two and three and study four was fully funded, including reimbursement of travel, swimming costume or trunks and pool fees. This enabled participants on low incomes to take part in the study, this population is sometimes underrepresented in research (NIHR 2022b). Research should be undertaken by people who

are competent and qualified in research methods and their field of study. This was ensured through the PhD supervision process, good clinical practice in research training, the PhD training programme, and through professional qualifications. Records of the research process should be kept for audit and review by the University and NHS trust and the research report should detail every step. The research records were kept in a secure location in the hospital and only anonymised data was transported outside the hospital. Research findings should be shared with the general public, academics and in the case of this project health and swimming professionals. Negative findings not just positive findings should be published. In the case of this project findings have been shared at a wide range of conferences and each study will be written up for journal publication.

3.13 Conclusion

This chapter has described the research design and research philosophy underpinning this project. To give context, the background of the researcher has been discussed, recognising that she is integral to the design and conduct of the project and interpretation of findings. The chapter has discussed and justified the research approach, methodology, research strategy, time horizon, sampling strategy, data collection methods, data analysis methods and ethical considerations. The study chapters which follow document the methods and results from the four studies, alongside discussion, conclusions, and recommendations.

Chapter 4

Study One: Survey of the Barriers, Enablers, and Preferences to Swimming for People with Chronic Low Back Pain

4.0 Introduction

When prescribing exercise to people with CLBP, it is best practice to consider the barriers, enablers and preferences impacting engagement (McGoldrick et al. 2016; NICE 2013; Thompson et al. 2020; van Stralen et al. 2009) as these determinants can have a negative or positive impact on exercise behaviour. In the case of this research project exercise behaviour refers to the uptake and maintenance of swimming. Some determinants will be personal to the individual, and others will be impacted by service provision and other stakeholders. Research has been conducted exploring determinants impacting land-based and aquatic-based exercise in the chronic pain population (Boutevillain et al. 2017; Fisken et al. 2016; Hornsby 2016; Joelsson et al. 2017; McPhail et al. 2014; Schaller et al. 2017) and impacting swimming engagement in the general population (Swim England 2017; 2019a; 2019b). To date, no research has been undertaken exploring the barriers, enablers and preferences impacting swimming uptake and engagement in the CLBP population. The COM-B model, introduced in the first chapter, explained how behaviour is part of an interacting system made up of capability, opportunity, and motivation (Michie, Atkins, and West 2014). It was recognised that in the case of this research project the model could be used to conduct a systematic analysis to better understand the nature of the determinants impacting swimming engagement and to identify intervention and implementation options to improve the prescription and delivery of swimming to this population.

The aim of this study was therefore to identify the most common swimming barriers, enablers, and preferences for people with CLBP, to map them onto the COM-B model and to use this data to guide the development of a swimming programme.

4.01 Research Question

What are the most common barriers, enablers, and preferences to swimming for people with CLBP?

4.02 Study Objectives

- To collect data concerning demographics, number of years with CLBP, swimming ability, experience, and preference.
- To identify the most common barriers, enablers, and preferences to swimming for people with CLBP and map them onto the COM-B model.

4.1 Methods

4.11 Study Design

Cross-sectional survey

4.12 Participants

Patients attending the physiotherapy and orthopaedic outpatient clinics at EKHUFT with CLBP were invited to take part in an online survey. Patients were eligible if they had experienced LBP for more than three months, were aged at least 18 years old and could speak and read English.

4.13 Questionnaire and Data Collection Procedures

The questionnaire consisted of 50 closed questions and 8 open questions, it was estimated to take between 10 and 15 minutes to complete, the survey did not ask for any identifiable information, see Appendix B for copy of questionnaire. The questions were developed based upon barriers and enablers to land and aquatic based exercise identified in research involving people with chronic pain (Boutevillain et al. 2017; Fisken et al. 2016; Hornsby 2016; Joelsson et al. 2017; McPhail et al. 2014; Schaller et al. 2017), to swimming in the general population (Swim England 2017; 2019a; 2019b) and the COM-B analysis. For example, the following question in the survey '*It is hard for me to find the time to go swimming during the week'* was developed based upon time being identified as a barrier in the study by Boutevillian et al. (2017) and McPhail et al. (2014) and time was identified as a barrier under physical opportunity in the COM-B analysis. The questionnaire was piloted with two people with CLBP to check ease of use, content, and comprehension; the questionnaire was amended based upon their feedback. See Tables 9, 10 and 11 for references supporting the questions developed in the questionnaire.

The initial questions collected demographic and background information including age, gender, ethnic group, marital status, employment status, education, smoking status, and number of years with LBP. The questions about swimming experience asked whether the participant could swim, how far they could swim, whether they had lessons as an adult, how frequently they swum and their reasons for going to a pool. The questions asking about

barriers and enablers to swimming were scored on a 5-point Likert scale. The participants were asked 17 questions about barriers, there were two parts to this section of the survey. Part one was introduced with the following statement: *'Would any of the following factors stop you from going to the swimming pool?'* Part two was introduced with: *'Would any of the following factors stop you from using swimming as a form of exercise?'* The participants were asked 12 questions about factors which might encourage them to swim. These questions were introduced with the following statement: *'This section is asking about factors that might encourage you to go swimming.'* The barriers section of the survey included two open questions which asked about medical reasons that could stop them swimming and adverse reactions to swimming in a pool. The questions about swimming preference included asking about the best time to swim, single gender swimming, adult only swimming, and swimwear. The questionnaire was amended prior to distribution due to the COVID-19 pandemic and lockdown restrictions and the participants were asked whether they had any concerns about returning to swimming in a public pool after the lockdown. The survey was distributed as an online questionnaire due to the COVID-19 measures; allowing the participants to complete the questionnaire at home at a convenient time reducing both infection risk and time burden.

Table 9: Development of questionnaire: What stops you from going to a swimming pool?

Barriers *What stops you from going to a swimming pool?*	**Chronic pain population and exercise**	**Chronic pain population and aquatic exercise**	**General population and swimming**	**COM-B analysis**
It is hard for me to find the time to go swimming during the week	Boutevillan et al. 2017; Joelsson et al. 2017; McPhail et al. 2014; Schaller et al. 2017			Physical opportunity
The cost of swimming prevents me from going swimming	Joelsson et al. 2017; McPhail et al. 2014; Schaller et al. 2017	Fisken et al. 2016		Physical opportunity
It is difficult for me to get to a pool due to transport reasons (car/bus routes)	McPhail et al. 2014			Physical opportunity
I find it hard to go swimming if I am not able to park close to the pool	McPhail et al. 2014			Physical capability
I struggle getting changed due to my back pain			Swim England 2019a	Physical capability
It is difficult for me to get from the changing room to the pool			Swim England 2019a	Physical capability
I am worried about falling or slipping in the pool area of changing room			Swim England 2019a	Psychological capability
It is difficult for me to get in and out of the pool			Swim England 2019a	Physical capability
I find that the swimming pool is too cold	McPhail et al. 2014	Fisken et al. 2016		Physical opportunity

Table 10: Development of questionnaire: What stops you from using swimming as a form of exercise?

Barriers *What stops you from using swimming as a form of exercise?*	**Chronic pain population and exercise**	**Chronic pain population and aquatic exercise**	**General population and swimming**	**COM-B analysis**
I can't swim very well			Swim England 2017	Physical capability
I have a fear of water			Swim England 2017	Psychological capability; Automatic motivation
I am worried that swimming will make my back pain worse	Boutevillan et al. 2017; Joelsson et al. 2017; McPhail et al. 2014; Schaller et al. 2017		Swim England 2017	Psychological capability
I have found that my back pain is worse while swimming	Boutevillan et al. 2017; Joelsson et al. 2017; McPhail et al. 2014; Schaller et al. 2017			Physical capability
I have found that my back pain is worse after swimming	Boutevillan et al. 2017; Joelsson et al. 2017; McPhail et al. 2014; Schaller et al. 2017			Physical capability
I am not sure which swimming stroke is best for my back pain	Boutevillan et al. 2017	Hornsby 2016		Psychological capability
I don't enjoy swimming	Boutevillan et al. 2017			Automatic motivation
I lack motivation to go swimming	Boutevillan et al. 2017; Joelsson et al. 2017; McPhail et al. 2014			Reflective motivation
I feel uncomfortable wearing a swimming costume or trunks	Joelsson et al. 2017			Psychological capability; Automatic motivation

Table 11: Development of questionnaire: What factors might encourage you to go swimming?

Enablers *What factors might encourage you to go swimming?*	**Chronic pain population and exercise**	**Chronic pain population and aquatic exercise**	**General population and swimming**	**COM-B analysis**
I find that I have less back pain when I am in the pool	McPhail et al. 2014			Physical capability
I find that swimming eases my back pain	McPhail et al. 2014			Physical capability
I believe that swimming is good for my back			Swim England 2017	Reflective motivation
I am able to do more in the water		Fisken et al. 2016		Physical capability
I enjoy swimming with my friends and / or family	Boutevillan et al. 2017; McPhail et al. 2014; Schaller et al. 2017	Fisken et al. 2016; Hornsby 2016	Swim England 2019b	Automatic motivation; Social opportunity
I like making new friends through swimming	McPhail et al. 2014	Fisken et al. 2016; Hornsby 2016	Swim England 2019b	Social opportunity
I think that setting goals and making an action plan could help me go swimming more regularly		Hornsby 2016		RM; Physical opportunity
I am more likely to go swimming if my health professional has advised me to go				Reflective motivation; Social opportunity
I would like to use swimming to improve my fitness and general health	McPhail et al. 2014	Fisken et al. 2016	Swim England 2019b	Reflective motivation
I would like to use swimming to improve my mood and wellbeing	McPhail et al. 2014		Swim England 2019b	Reflective motivation
I would like to use swimming to improve my muscle strength and flexibility	McPhail et al. 2014		Swim England 2019b	Reflective motivation
I would like to use swimming to help me maintain a healthy weight or lose weight	McPhail et al. 2014	Fisken et al. 2016	Swim England 2019b	Reflective motivation

4.14 Data Analysis

The survey data was collected using an online platform, Online Surveys (https://www.onlinesurveys.ac.uk/) and analysed in Excel. The responses for the barriers and enablers were ranked by the percentage of participants who agreed or strongly agreed with the statement, compared to those who disagreed with the statement and the neutral responses. The data was analysed using the following data analysis methods; median, interquartile range, and percentages. The mean was not chosen as a measure of central tendency for this section of the data, due to outliers in the data (Field 2009). The responses were ranked by percentage of participants who agreed with the statement, in order to determine the most popular responses. To understand the distribution of the responses the data was divided into quartiles; the term quartiles refer to the three values when ordered data is cut into four equal parts (Field 2009). Two thresholds were set using the middle (>50%) and upper quartiles (>75%) and to determine the majority and most common responses in this sample of participants. In survey research there is a wide range of choice of thresholds set for consensus, choice can be based upon the research topic, with high-risk topics setting higher thresholds (Keeney, Hasson, and McKenna 2006). Barriers and enablers to exercise is not a high risk-topic, therefore the choice of 75% benchmark was appropriate for this research topic. 75% has been calculated to be the median threshold for consensus (Diamond et al. 2014). Descriptive statistics were used to analyse the closed responses as no hypothesis had been set. The open responses were reported, and quotes were cited to give examples. A questionnaire combining closed responses and open responses is usually considered a quantitative method unless the open responses are analysed using a rigorous methodology (Pluye et al. 2018). The questions about barriers and enablers were mapped on the COM-B model using the process described by Michie, Atkins, and West (2014) to gain a better understanding of the nature of these determinants.

4.2 Results

127 patients were invited to complete the survey and 82 participants completed the survey; therefore, the response rate was 64.6%. Table 12 reports the participant characteristics and Table 13 the swimming ability and experience.

Table 12: Participant characteristics study one

Demographics	**All participants (n=82)**
Median age y, (IQR)	52.5, (21.75)
Gender female, %, (n)	62, (51)
Ethnic group White British, %, (n)	96.3, (79)
Unemployed or unable to look for work, %, (n)	14.6, (12)
Married or domestic partnership, %, (n)	68.3, (56)
Education up to university level, %, (n)	39, (32)
Median number of years with back pain y, (IQR)	10.5, (17)
Smoker, %, (n)	11, (9)

IQR: Interquartile range; y: years

Table 13: Swimming ability and experience

Swimming ability and experience	**All participants (n=82)**
Able to swim, %, (n)	84.1, (69)
Able to swim 50m or more, %, (n)	52.4, (43)
Had swimming lesson as an adult, %, (n)	9.8, (8)
Been swimming in last month, %, (n)	25.6, (21)
Go to pool for other reason, %, (n)	22, (18)

IQR: Interquartile range; y: years

4.21 Swimming Preference

The participants were asked what time of day was best for them to swim. The most popular time was in the morning (9-12pm), 34.2% (n=26) of participants selected this option, the second most popular time was early evening (5-7pm) with 21.1% (n=16) choosing this time. 91.0% (n=71) of participants said that they would prefer to attend an adult only session. 42.0% (n=21) of female participants and 8.0% (n=2) of male participants said they would prefer to attend a swimming session with just female or just male swimmers. 39.0% (n=20) of female participants said they would prefer a session where you were allowed to wear a t-shirt compared to 21.4% (n=6) of male participants.

4.22 Barriers to Swimming

Less than 75% of the participants in the survey agreed with all of the barriers suggested in this survey. More than 50% of the participants agreed with the following barriers: *'I am not sure which swimming stroke is best for my back pain'* and *'I lack motivation to go swimming.'* More than 50% of participants disagreed with the following barriers: *'It is difficult for me to get in and out of the pool', 'I find it hard to go swimming if I am not able to park close to the pool', 'It is difficult for me to get from the changing room to the pool' and 'I have a fear of water.'* More than 75% of participants disagreed with the barrier: *'It is difficult for me to get to a pool due to transport reasons.'* More than 50% of participants chose a neutral response for the following barrier: '*I have found that my back pain is worse after swimming*.' See Tables 14 and 15 for the barriers ranked by percentage of the participants who agreed with the statements and Figure 11 for the barriers whereby the majority of participants agreed with the statement mapped onto the COM-B model.

Table 14: What stops you from going to a swimming pool?

Barriers	**COM-B**	**Agree %, (n)**	**Disagree %, (n)**	**Neutral %, (n)**
It is hard for me to find the time to go swimming during the week	PO	47.5, (39)	34.1, (28)	18.3, (15)
I am worried about falling or slipping in the pool area of changing room	PsC	43.9, (36)	41.4, (34)	14.6, (12)
The cost of swimming prevents me from going swimming	PO	37.8, (31)	45.1, (37)	17.1, (14)
I struggle getting changed due to my back pain	PC	32.1, (26)	45.6, (37)	22.2, (18)

It is difficult for me to get in and out of the pool	PC	28.9, (24)	50.6*, (42)	20.5, (17)
I find that the swimming pool is too cold	PO	23.5, (19)	45.7, (37)	30.9, (25)
I find it hard to go swimming if I am not able to park close to the pool	PC	19.3, (16)	62.7*, (52)	18.1, (15)
It is difficult for me to get from the changing room to the pool	PC	12.0, (10)	61.4*, (51)	26.5, (22)
It is difficult for me to get to a pool due to transport reasons (car/bus routes)	PO	11.0, (9)	81.7*, (67)	7.3, (6)

**>75% agreement; *>50% agreement; Physical capability (PhC); psychological capability (PsC); physical opportunity (PO); social opportunity (SO); reflective motivation (RM); automatic motivation (AM)

Table 15: What stops you from using swimming as a form of exercise?

Barriers	**COM-B**	**Agree %, (n)**	**Disagree %, (n)**	**Neutral %, (n)**
I am not sure which swimming stroke is best for my back pain	PsC	58.0*, (47)	14.8, (12)	27.2, (22)
I lack motivation to go swimming	RM	57.5*, (46)	17.5, (14)	25.0, (20)
I feel uncomfortable wearing a swimming costume or trunks	PsC; AM	43.4, (36)	37.3, (31)	19.3, (16)
I don't enjoy swimming	AM	32.1, (26)	46.9, (38)	21.0, (17)
I can't swim very well	PC	31.0, (26)	47.6, (40)	21.4, (18)
I am worried that swimming will make my back pain worse	PsC	31.3, (25)	45.0, (36)	23.8, (19)
I have found that my back pain is worse after swimming	PC	21.0, (17)	27.2, (22)	51.9*, (42)
I have a fear of water	PsC; AM	18.3, (15)	74.4*, (61)	7.3, (6)
I have found that my back pain is worse while swimming	PC	14.6, (12)	42.7, (35)	42.7, (35)

**>75% agreement; *>50% agreement; Physical capability (PhC); psychological capability (PsC); physical opportunity (PO); social opportunity (SO); reflective motivation (RM); automatic motivation (AM)

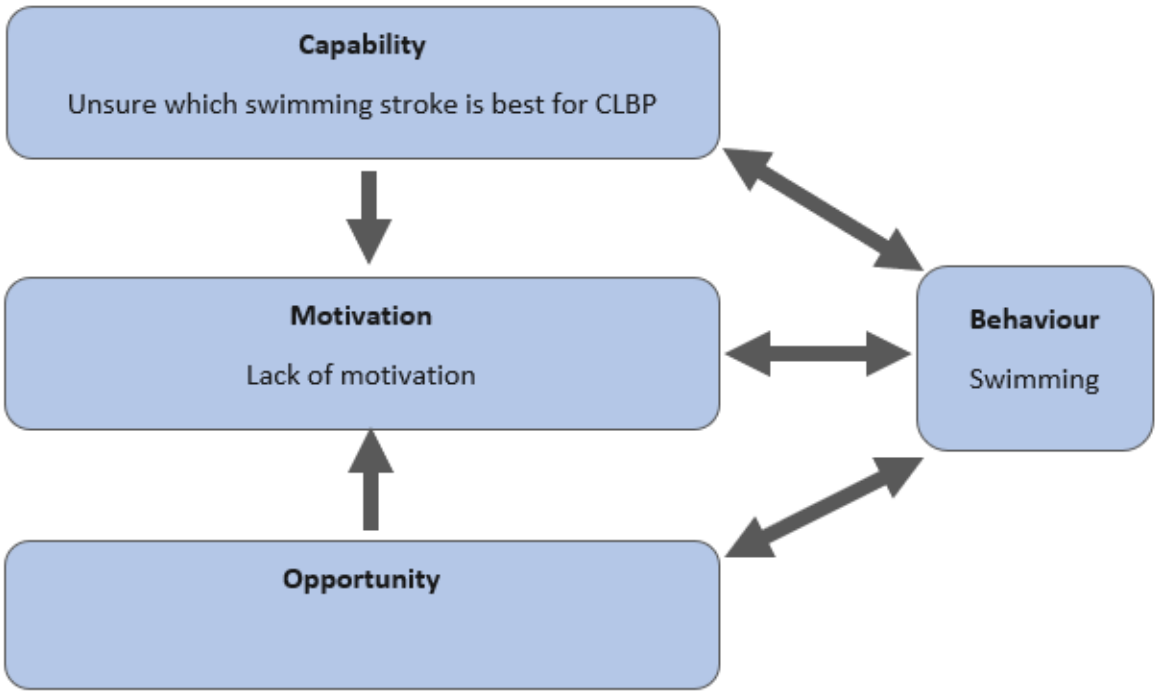

Figure 11: Barriers mapped onto COM-B model

4.23 Medical History and Adverse Reactions

The barriers section of the survey included two open questions; '*I have a medical reason that stops me swimming'* and *'I have experienced an adverse reaction to swimming in a poo*l'. For the first question there were ten responses, the following conditions were mentioned once, breathing problems, short-sighted, fear of drowning and elbow pain. Back pain was mentioned by four participants *'Back pain puts me off swimming'* and skin conditions by two participants *'Eczema which becomes very sore after being in the water'*. The most common adverse reaction mentioned was ear problems, this was reported by four participants along with an explanation of how they overcome this problem. ''*I have twice had ear infections requiring antibiotics, I now wear earplugs.'* The second most common reaction was nose and sinus problems which were reported by three participants along with an explanation of how they overcome this problem; *'I swim a lot and started experiencing running water several hours after my swim. I now use a nose clip which prevents this.'* Two participants mentioned eye issues or concerns about eyes; '*The chlorine makes my eyes sore for days even if I wear goggles.'* Two participants mentioned two conditions affecting the foot associated with swimming: verruca and toenail fungus. One participant mentioned that front crawl and

backstroke tends to cause shoulder pain and another participant mentioned suffering a back spasm whilst swimming.

4.24 COVID-19

For context, this data was collected between July and December 2020; a period between two national lockdown periods in England. Most of the survey data was collected while the pools were open. The participants were asked whether they had any concerns about returning to swimming in a public pool after the lockdown. 30.9% (n=25) had concerns about returning to swimming and 15% (n=12) said that they would not return to swimming after the lockdown period. Three barriers were discussed, these were concerns about infection, change in pool procedures and pools not reopening. The concerns are illustrated by these comments: *'At the moment do not feel safe due to other people who do not care about coronavirus'; 'Being too close to people as you cannot wear a mask in the pool.'* Reasons for not planning on returning to swimming included *'Partner with no immune system will not put him at risk'; 'It's the changing areas that I would be concerned about'.*

4.25 Enablers to Swimming

The two enablers whereby more than 75% of the participants agreed with the statement were: *'I would like to use swimming to improve my muscle strength and flexibility'* and *'I would like to use swimming to help me maintain a healthy weight or lose weight.'* More than 50% of participants agreed with the following statements: *'I would like to use swimming to improve my fitness and general health', 'I would like to use swimming to improve my mood and wellbeing', 'I think that setting goals and making an action plan could help me go swimming more regularly', 'I am more likely to go swimming if my health professional has advised me to go',* and *'I believe that swimming is good for my back.'* More than 50% of participants chose a neutral response to the following enablers: '*I find that I have less back pain when I am in the pool,' 'I am able to do more in the water', 'I find that swimming eases my back pain'* and *'I like making new friends through swimming.'* See Table 16 for the enablers ranked by percentage of the participants who agreed with the statements and Figure 12 for the enablers whereby the majority of participants agreed with the statement mapped onto the COM-B model.

Table 16: What factors might encourage you to go swimming?

Enablers	COM-B	Agree %, (n)	Disagree %, (n)	Neutral %, (n)
I would like to use swimming to improve my muscle strength and flexibility	RM	77.8**, (63)	6.2, (5)	16.0, (13)
I would like to use swimming to help me maintain a healthy weight or lose weight	RM	75.3**, (61)	8.6, (7)	16.0, (13)
I would like to use swimming to improve my fitness and general health	RM	72.8*, (59)	8.6, (7)	18.5, (15)
I would like to use swimming to improve my mood and wellbeing	RM	70.4*, (57)	9.9, (8)	19.8, (16)
I think that setting goals and making an action plan could help me go swimming more regularly	RM; PO	61.7*, (50)	13.6, (11)	24.7, (20)
I am more likely to go swimming if my health professional has advised me to go	RM; SO	61.7*, (50)	17.3, (14)	21.0, (17)
I believe that swimming is good for my back	RM	50.6*, (41)	4.9, (4)	44.4, (36)
I enjoy swimming with my friends and / or family	AM; SO	39.5, (32)	16.0, (13)	44.4, (36)
I find that I have less back pain when I am in the pool	PC	38.3, (31)	11.1, (9)	50.6*, (41)
I am able to do more in the water	PC	36.3, (29)	10, (8)	53.8*, (43)
I find that swimming eases my back pain	PC	23.5, (19)	11.1, (9)	65.4*, (53)
I like making new friends through swimming	SO	13.5, (11)	30.8, (25)	55.6*, (45)

**>75% agreement; *>50% agreement; Physical capability (PhC); psychological capability (PsC); physical opportunity (PO); social opportunity (SO); reflective motivation (RM); automatic motivation (AM)

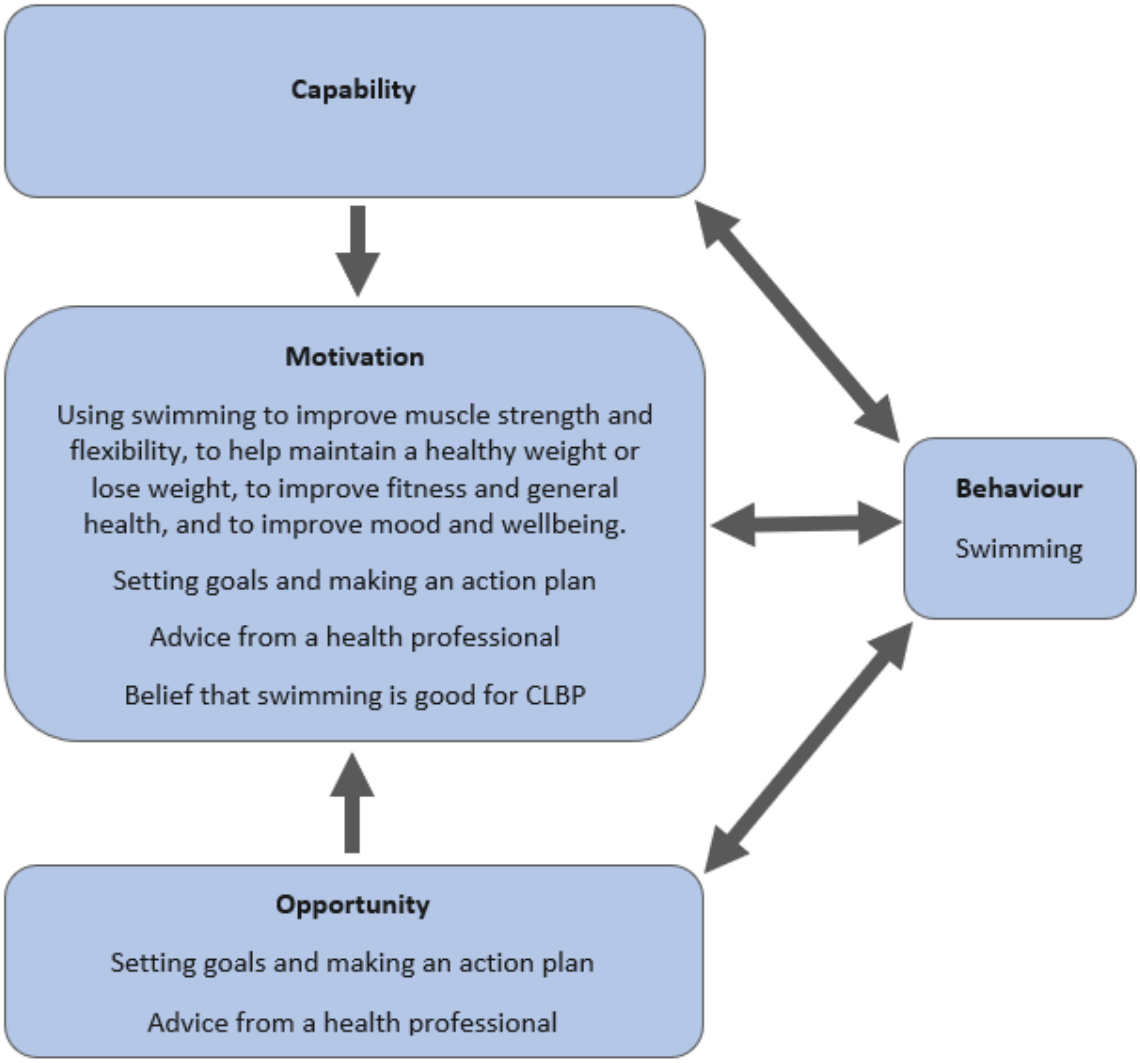

Figure 12: Enablers mapped onto COM-B model

4.3 Discussion

4.31 Participant Characteristics

The survey aimed to identify the most common barriers, enablers, and preferences to swimming for people with CLBP, to map them onto the COM-B model and to use this data to guide the development of a swimming programme for this population. The participants were recruited from NHS physiotherapy and orthopaedic clinics in an acute trust in East Kent. Demographic and background data collected in surveys can be used in several ways. It can show whether the participants in the survey were representative of the population being studied, provide context for the results, and be used to subdivide responses so that differences in responses can be understood between groups. Although the majority of clinic patients were invited to take part in the survey, the data demonstrated that the majority were employed and identified as White British. It is recognised that certain sections of the general population are less likely to take part in research, and that underrepresented groups in research include people from ethnic minority groups and people who are unemployed (George, Duran, and Norris 2014; NIHR 2020; Quay et al. 2017). In this study, demographic data could have been collected from everyone invited to take part in the survey and compared to those who completed the survey to discover whether the study cohort was representative of the clinic population. With a better understanding of under representative groups barriers to inclusion for these groups could be considered in future surveys (NIHR 2020). The majority of participants in this survey were white, despite the survey being shared with people from all ethnic groups. It is known that people in Black, Asian, and other minority ethnic groups are less likely to be able to swim (Brown 2014), for example in the UK it has been found that 95% of black adults do not swim (Black Swimming Association 2020). Rates of inequality could be higher in populations with long-term pain (Oakes et al. 2020). It is acknowledged that people from minority ethnic groups may feel excluded and face different barriers due to cultural privacy, dress code, and language, meaning that they may require additional support when taking up swimming (STA 2021; Swim England 2016).

4.32 Swimming Preference

Preference can be measured as the response when presented with two or more choices (Aboagye 2017). This survey found that 91% of participants would prefer to attend an adult only session and 42% of females would like to attend a session with just female swimmers. When discussing swimming, health professionals should consider signposting people to their preferred sessions and pool operators should provide a range of sessions. The two most popular times to swim were in the morning between 9-12pm and during the early evening from 5-7pm. Research in the field of chronic pain has identified three circadian pain rhythms; pain that is highest on waking and then decreases, pain that is high on waking and decreases but increases again mid-afternoon and pain that builds up through the day (Tanaka et al. 2021). The choice of time of day could have been influenced by a circadian pain rhythm and daily commitments.

4.33 Common Barriers to Swimming

None of the responses in the barriers section of the survey reached the higher threshold of greater than 75%. More than 50% of participants agreed that not being sure which swimming stroke is best for CLBP and lack of motivation could be a barrier to swimming. It is already known that people with LBP are often advised to avoid breaststroke (Hofling et al. 2002, Liyanage 2020, Young 2016), particularly those with poor tolerance of lumbar extension (Dunlap 2009), however the scoping review in chapter two identified limited research to support or negate this recommendation (Coleman, Persyn and Winters 2000; Hofling et al. 2002). This barrier would come under the psychological capability dimension of the COM-B model; meaning that people with CLBP are unsure how to use swimming due to lack of knowledge. This suggests that people with CLBP may require further information when being prescribed swimming and vague advice to try swimming without guidance on stroke and technique could be a barrier impacting uptake. Furthermore, the findings support the need for collaboration between health and swimming professionals and further research on strokes and the impact on LBP to enable clearer guidance to be provided to this population.

Lack of motivation has been found to be a barrier to exercise in other studies involving people with LBP (Boutevillain *et al.* 2017), chronic pain (Joelsson *et al.* (2017), and musculoskeletal disorders (McPhail *et al*. (2014). The arrows in the COM-B model demonstrate the interplay between motivation, capability, opportunity, and behaviour; illustrating that both capability

and opportunity need to be present in order for motivation to generate a change in behaviour (Michie, Atkins and West 2014). In practice this means having the motivation to swim will not enable a person to swim unless they have the capability and opportunity to swim. This interplay in the model illustrates the impact of one barrier on other barriers and cautions against simply directing rehabilitation to addressing motivation. In the COM-B model motivation is split into reflective motivation which involves planning and evaluation and automatic motivation which relates to emotions and desires. Reflective motivation could be targeted by goal setting and making and action plan which 61.7% of the participants agreed would help them go swimming more regularly. Automatic motivation could increase or decline, depending on the emotions experienced when swimming (Banting, Dimmock and Grove 2011). In this present survey 18% of participant agreed that they had a fear of water, 32% agreed that they did not enjoy swimming and 45% felt uncomfortable wearing a swimming costume or trunks, these emotions could have a negative impact on automatic motivation. It could be suggested that by delivering an enjoyable and supportive swimming programme to this population that automatic motivation could increase, improving the chance of long-term behaviour change.

Swimming is not without risk, one of the open questions had asked whether the participants had experienced an adverse reaction to swimming in a pool. The most common adverse reactions to swimming were ear, nose, and eye problems. Ear problems are relatively common in swimmers but can be addressed with ear plugs and ensuring that the ear is dried after swimming (Agius, Pickles, and Burch 1992; Wang et al 2005). Some people can react to the chlorine in pool water, this problem could be addressed by wearing a nose clip and goggles and by trialling different pools (Fernandez-Luna et al. 2016; Ishioka et al. 2008). Two participants had mentioned problems with toe fungus and verruca, which again could be addressed by thoroughly drying the feet and wearing poolside shoes. Health and swimming professionals should consider discussing these potential reactions to swimming as they could be modifiable with the right measures and equipment.

4.34 Common Enablers to Swimming

More than 75% of participants in the survey agreed that using swimming to improve strength and flexibility, maintain a healthy weight or lose weight would encourage them to go swimming and more than 50% of participants agreed that they would like to use swimming

to improve fitness, general health, mood, and wellbeing. When mapped onto the COM-B these enablers would come under the reflective motivation dimension. Swim England, one of the national swimming bodies, undertook a review in 2019 exploring the value of swimming (Swim England 2019b); this review and the media coverage could be one reason why the participants were aware of the wider health benefits of swimming. The Lancet series of papers on CLBP published in 2018 recommended that in order to reduce the impact of CLBP on daily life public health programmes should be developed to target physical activity and obesity and that care should focus on living well with CLBP and adopting a healthy lifestyle (Buchbinder et al. 2018). Other leading physiotherapists have agreed that it is important to reframe the care provided to people with long-term pain; focusing on the wider benefits of physical activity and change in lifestyle rather than trying to 'cure' what is essentially a long-term condition which needs to be managed (Lewis and O'Sullivan 2018). In support of this recommendation, this study found that only 24% of participants agreed that a reduction in CLBP through swimming would encourage them to swim. The finding from this survey suggest that health professionals should focus on the wider benefits of swimming, rather than CLBP and more work should be carried out by the national swimming bodies to provide information about the benefits to the general public.

Being advised swimming by a health professional was recognised as an enabler by more than 50% of participants, illustrating that conversations between a patient and a health professional could encourage someone to take up swimming. This enabler could be mapped onto two dimension on the COM-B model; reflective motivation and social opportunity. Social opportunity links with the '*Making Every Contact Count*' (MECC) programme, which enables health and care professionals to start conversations with patients and clients, encouraging them to think about changing modifiable risk factors such as physical activity and offering or signposting to further support (NICE 2023). The MECC approach encourages the use of brief or very brief advice during routine contacts. Brief advice has been found to increase levels of physical activity in the sedentary population (Babwah et al. 2018) but to date no research has been undertaken exploring the impact of this technique on uptake of swimming. Brief advice can include advice, discussion, negotiation, and encouragement but can also include the use of behaviour change techniques such as goal setting (CSP 2023). In this present study more than 50% of participants agreed that behaviour change techniques, such as setting goals and

making an action plan, could be enablers to swimming. A written action plan for swimming could include documenting when, where, who the individual will swim with, alongside how they might overcome any barriers (Society of Behavioural Medicine 2023). Planning interventions such as goal setting and action planning have been found to be effective at improving physical activity behaviour (Belanger-Gravel, Godin, and Amireault 2013; Handley et al. 2006; Peng et al 2022). The findings from this survey suggest that health professionals should incorporate the use of goal setting and the formulation of an action plan when recommending swimming.

4.35 Other Barriers and Enablers to Swimming

Although this study set a thresholds of greater than 50% and 75% to determine the majority and most common barriers and enablers, all barriers and enablers included in this survey should be considered. Moreover, it was recognised that physiotherapists cannot address all the barriers in this survey; some barriers would need to be addressed by pool operators, local government, and health commissioners. For example, pool operators could make changes to the pool temperature, pool access and changing rooms, health commissioners could direct additional funding to exercise referral schemes to prevent cost being a barrier and local government could consider improving public transport to pools. There were three barriers in part one which could be addressed by health professionals; these were: *'It is hard for me to find the time to go swimming during the week', 'I am worried about falling or slipping in the pool area of changing room'* and *'I struggle getting changed due to my back pain.'* Research has found that older adults with CLBP have an increased risk of falls (Bell et al. 2021; Marshall et al. 2016). The provision of walking aids for use in the changing room, and advice about footwear and changing aids could address the second two barriers and making an action plan with a health professional could help address the barrier of time (Handley et al. 2006). The framework for growing swimming by Swim England (2017) had considered swimming environment barriers such as cleanliness, showers, hairdryers, and lockers but had not considered the pool surface and concerns about slips and falls. Many of the barriers in part two and the enablers related to lack of swimming ability and the enjoyment of swimming. This present survey reported similar rates of lower levels of swimming ability to the Swim England '*Value of Swimming Report*' (Swim England 2019b), suggesting that a third of people with CLBP could benefit from having swimming lessons.

Forty-five percent of participants in this survey agreed that feeling uncomfortable in a swimming costume or trunks could be a barrier to swimming. This barrier to swimming has also been identified as being one of the top five barriers in other surveys (Outdoorswimmer.com 2022). Feeling uncomfortable in a swimming costume is likely to be related to body image. A women and equalities committee survey found that 61% of adults and 71% of adults with a disability reported feeling negative or very negative about their body image most of the time (House of Commons Women and Equalities Committee 2020). The Swim England framework for growing swimming has recommended that pool operators allow t-shirts to be worn in the pool and add poolside hooks for towels to help create an inviting environment (Swim England 2017). Further work by the national swimming bodies and pool operators should be undertaken to address this barrier.

4.36 COM-B Model

The barriers and enablers were mapped onto the COM-B model. More than 75% of participants agreed with enablers that linked to the reflective motivation dimension and more than 50% agreed with enablers that linked to the reflective motivation, physical opportunity, social opportunity, and automatic motivation dimensions. Under barriers section more than 50% agreed with barriers in the psychological capability and reflective motivation dimensions. The introduction chapter had suggested that swimming ability (physical capability) could be a barrier for many adults, however the findings from this COM-B analysis suggests that although this is a factor for some it could have less impact on swimming uptake and engagement. These findings suggest that when recommending or delivering swimming to people with CLBP, although all dimensions should be considered, the swimming programme should include methods utilising reflective motivation. When mapped onto the BCW the following implementation options could be considered; training, education, enablement and restructuring the environment.

4.37 Strengths and Limitations

The sample size for this survey was smaller than anticipated, the aim was to recruit 350 people however only 82 participants completed the survey. Due to the COVID-19 pandemic there were extra pressures on staff and therefore the survey was shared with fewer patients. The findings from this study would not be generalisable to the population as greater numbers would need to be sampled, however the study has provided sufficient data to guide the development of the swimming programme in study three. The demographic data showed that certain groups were not included in the survey, such as people who were unemployed and ethnic minority groups. A follow up survey could be conducted to determine the barriers and enablers in these under-represented populations, addressing ways to make the survey more inclusive and accessible to these groups. The results from this survey may only apply to the population of East Kent, similar surveys may need to be undertaken in other geographical areas to find out whether the responses are similar. Responses to the survey may have been different if it had not been conducted during the COVID-19 pandemic, as during this period of time there were additional concerns about risk of infection and variable access to pools. The pools were open during the survey period, however not everyone had returned to swimming. The findings from this survey suggested that there were additional barriers to swimming during this time period including concerns about infection, new pool procedures and pools not reopening. In March 2023 a poll found that one in five adults in Great Britain still have concerns about the risk of COVID-19 infection when in public places (Office for National Statistics 2023), suggesting that concerns about infection could still be a barrier to swimming in 2023. This limitation highlights the need for researchers to report the time period when the data is collected so that readers are aware of the context and whether the findings are applicable to their population. If the survey was conducted at another time period, other factors could emerge as barriers, such as the rising cost of living and the energy crisis in 2022/23 which has resulted in the closure of some pools and pools operating at lower temperatures (Better 2023; Financial Times, 2022; Swim England 2022).

Over 50% of participants chose a neutral response for the following barriers: '*I have found that my back pain is worse after swimming*' and the following enablers: '*I find that I have less back pain when I am in the pool,' 'I am able to do more in the water', 'I find that swimming eases my back pain'* and *'I like making new friends through swimming.'* The neutral responses

in Likert data can be impacted by social desirability and central tendency bias (Nadler, Weston and Voyles 2015). Several studies have explored how participants interpret a neutral midpoint on a Likert scale, finding that a neutral response can be due to not having an opinion, being undecided or having a middle opinion (Baka et al. 2012). '*Undecided*', '*no opinion'* and '*prefer not to answer'* options could be included in future surveys of this population in order to gain a better understanding of viewpoints. The high levels of neutral responses in this present survey to certain questions could indicate that many participants were undecided, and these barriers and enabler should be explored further, possible using qualitative methods.

Despite the limitations, the study has value in that it is the first study to identify the most common barriers, enablers, and preferences to swimming for people with CLBP. The results have been mapped onto the COM-B model, enabling a better understanding of the nature of these determinants to guide the choice of intervention and implementation options in study three. The study findings could provide guidance for health professionals when prescribing swimming, guide the development of resources for people with CLBP, and inform future research exploring the delivery of swimming to people with CLBP. Beyond healthcare the results could be of interest to swimming professionals, pool operators, health commissioners and local government.

4.4 Conclusions and Recommendations

The results from this survey add to what is already known about barriers, enablers, and preferences to physical activity for people with CLBP and to swimming in the general population. The results have been used to guide study three and four, but the findings also have merit on their own; providing data to guide health professionals when prescribing swimming, swimming professionals when delivering swimming and other stakeholders when providing and funding swimming. The survey findings illustrate briefly recommending swimming to people with CLBP may not translate to uptake due to the range of barriers, enablers, and preferences, supporting the rationale for developing a swimming programme for this population. The findings suggest that health professionals should ask about barriers, enablers and preferences when prescribing swimming and work collaboratively to problem solve how these barriers can be overcome and how enablers can be utilised. The findings from the COM-B analysis suggests that health professionals should consider using motivational tools to encourage reflective motivation and discuss the wider benefits of swimming, provide specific guidance regarding the choice of swimming strokes and signpost less able swimmers to lessons. Although identifying the most common barriers and enablers have value in terms of system change it should be recognised that an understanding of individual barriers enables a tailored approach to be taken in clinical practice. Furthermore, due to the nature of the determinants, it is acknowledged that healthcare professionals can only address some determinants to engagement in swimming and that it is also the responsibility of other stakeholders including healthcare commissioners, swimming professionals, pool operators, local government, and the national swimming bodies. The range of responses in the survey and recognition of stakeholder impact and interaction on these determinants supports the suggestion that swimming as a rehabilitation modality would be a complex intervention. Future research in this field could use qualitative methods to explore what support or changes people with CLBP might need to overcome barriers and to gain a better understanding of preferences when swimming.

Chapter 5

Study Two: Learning to Swim with Back Pain: A Qualitative Study of Swimmers with Chronic Low Back Pain

5.0 Introduction

Swimming is often recommended to people with CLBP for rehabilitation, pain management and to improve levels of physical activity (Cole et al. 1997; Ribaud et al. 2013), however there is limited data on the uptake and use of swimming by this population (Baptistia, Abrantes and Atalaia, 2020; Oakes et al. 2020; Setchell et al., 2019). To promote the value of swimming Swim England have published testimonials whereby swimming has had a positive impact on health (Swim England 2019a) and several books have been published by people who have discovered and use swimming to manage and improve their physical and mental health (Deacon and Allan, 2019; Hemingsley 2017; Landreth 2017). Although these stories are of interest, they have limited value as they are single person case studies. To date there has been no attempt to use research methods to evaluate and synthesise the experiences of swimmers with CLBP or other health conditions to identify whether there are common themes in these stories and experiences. Gaining an insight into what it feels like to use swimming to manage CLBP and to understand the world as the swimmer experiences it would provide valuable data in this field to guide future research (Austin and Sutton 2014). The aim of this study was to use semi-structured interviews to explore the experience of people who use swimming to manage CLBP.

5.01 Research Question

What is the experience of swimmers who use swimming to manage CLBP?

5.02 Study Objectives

- To explore the experience of swimmers who use swimming to manage CLBP.
- To discuss the following topics through semi-structured interview: experience of CLBP and swimming with CLBP, why they chose swimming, other strategies to manage CLBP, modifications, and adaptations to swimming, strokes and drills they found helpful or unhelpful, setbacks and management of setbacks, frequency of swimming, time in water and motivation to keep swimming and keep active despite having CLBP.
- To use a combination of a priori codes and develop inductive codes to analyse the interviews, developing themes and subthemes, map the subthemes onto the COM-B model and use this data to guide the development of the swimming programme in study three.

5.1 Methods

5.11 Study Design

Qualitative study utilising semi-structured interviews.

5.12 Participants

Swimmers were recruited by advertising the study on both pool swimming and outdoor swimming social media groups. Swimmers were eligible if they had experienced LBP for more than 3 months, they used swimming to manage their LBP, were aged at least 18 years old and they could speak or read English.

5.13 Data Collection Procedures

The interviews were conducted in person outdoors, via video conference platform or via zoom. The topics discussed in the interview included their experience of CLBP and swimming with CLBP, why they chose swimming, other strategies used to manage CLBP, modifications and adaptations to swimming, strokes and drills they found helpful or unhelpful, setbacks and management of setbacks, frequency of swimming, time in water and their motivation to keep swimming and keep active despite CLBP. An interview guide was used to help ensure that all topics were covered, see Appendix C for copy of interview guide. The interviews were recorded and transcribed verbatim by the researcher. The participants were emailed the transcripts to check content and to give them an opportunity to make any changes; they also received a £25 thank you voucher for taking part in the study. Recruitment continued until no new themes emerged during the interviews and analysis.

5.14 Data Analysis

Thematic analysis was used to analyse the interview data. The researcher read all the transcripts to get familiar with the data and then started making notes and coding the data, using a combination of a priori codes and through the development of inductive codes. The a priori codes that were used during the thematic analysis included the different swimming strokes; front crawl / freestyle, backstroke, breaststroke, and butterfly. Other a priori codes included mention of single strokes or mixing strokes, warmup, dryland conditioning, swimming location, equipment, and swimming dose. The reason for choosing these a priori codes was that it was expected that these codes were arise during the data analysis based on

the questions in the interview guide. Also, these a priori codes would be useful for development of the swimming programme in study three. The inductive codes that were developed during the analysis included something that: was repeated, was important to the swimmers, which was included in the back-pain guidelines or relevant theoretical frameworks, that aligned with the research objectives and the key concepts in the interview guide. Codes were collated into possible themes and a thematic map was generated to check the themes and subthemes. The process of analysis was not linear and involved many versions refining the coding, subthemes and themes before the final themes were generated. NVivo version 12 was used to help organise the data when coding. It was recognised that the researcher's world view on the research topic could shape both the research design and the data analysis. A reflexivity statement has been included in the study chapter exploring personal, interpersonal, methodological, and contextual dimensions. To improve the credibility of the data and recognising the pragmatic concepts of plurality and subjectivity, subthemes and themes were checked also by the supervisory team, some were changed or adapted for the final version. The subthemes were mapped onto the COM-B model using the process described by Michie, Atkins, and West (2014) in order to understand how they could impact the behaviour of swimming, to guide the development and refinement of the swimming programme.

5.2 Results

5.21 Swimmer Characteristics

Fourteen swimmers were interviewed, four male and ten female; six were pool swimmers, five were outdoor swimmers and three swimmers swam both in the pool and outdoors, see Figure 13.

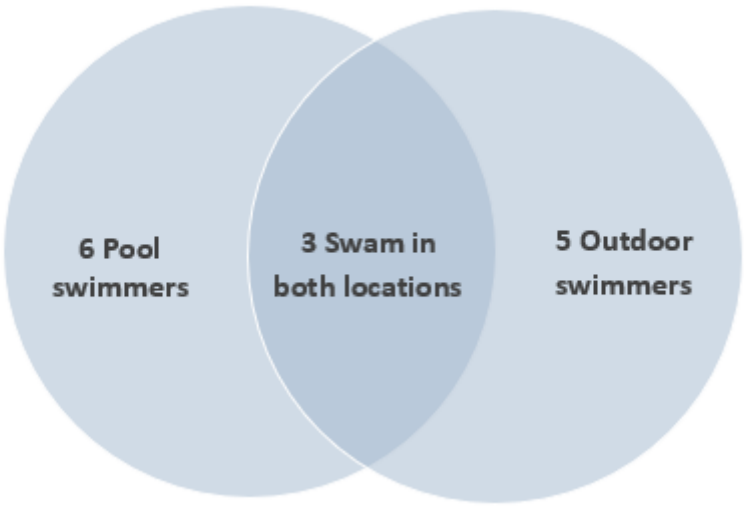

Figure 13: Swimming location

The number of years the swimmers had experienced CLBP ranged between 3 and 45 years, median 25 years, interquartile range 10 years. The interview length ranged from 14 minutes to 41 minutes, median time 25 minutes. Table 17 provides a summary of the swimmer characteristics.

Table 17: Swimmer characteristics study two

Swimmer	Location	Female / Male	Years with back pain	Long-term / recent swimmer
1	Outdoor	Female	30	Recent
2	Pool	Male	30	Long-term
3	Pool	Female	40	Long-term
4	Both	Male	40	Long-term
5	Both	Male	25	Long-term
6	Both	Female	20	Long-term
7	Outdoor	Male	20	Long-term
8	Pool	Female	30	Long-term
9	Outdoor	Female	25	Recent
10	Outdoor	Female	3	Recent
11	Pool	Female	5	Long-term
12	Pool	Female	20	Long-term
13	Outdoor	Female	45	Long-term
14	Pool	Female	6	Long-term

5.22 Data Saturation

The number of participants recruited for this study was based upon data saturation models. It is acknowledged that data saturation is a process and not a discrete end point, there is always the potential for more themes to emerge and for this reason saturation should be assessed using evidence from data saturation models (Saunders et al. 2018). The number required to reach saturation varies and can be dependent on many factors including the heterogenicity of the participants and the study aims (Mason 2010). The participants in this study were well defined, swimmers with CLBP, due to the specific inclusion criteria and the reason for carrying out the interviews was also clearly defined. This meant that data saturation could be achieved with a smaller sample size than if a broader group had been interviewed, for example swimmers with general musculoskeletal pain, and if it had taken a grounded theory approach. It has been suggested that 12 interviews are usually required for data saturation (Guest, Bunce, and Johnson 2006), therefore initially this was set as the benchmark for the minimum number of swimmers. During the study different models of data saturation were employed; including data saturation, a prior thematic saturation, and inductive thematic saturation (Saunders et al. 2018) to ensure that sufficient swimmers were interviewed. The data saturation model was assessed by the researcher during the interviews, once it was clear that the same themes were being discussed then no further swimmers were recruited, and the initial data analysis could commence. The a priori thematic data saturation model was

assessed through the a priori codes developed and during the initial data analysis, if there were similar responses for these codes then it was assumed that data saturation had been achieved. With regards to inductive thematic saturation this was assessed during the data analysis, once no new codes or themes were developed then it could be concluded that data saturation had been achieved and no more swimmers were recruited.

5.23 Themes

The interview data provided a rich multi-dimensional view of the experience of using swimming as a self-management tool for CLBP. Each swimmer had their own unique biography and experiences; however, five common themes were developed during the analysis. Table 18 provides a summary of the themes and subthemes. For each theme a thematic map and a table has been included; the table provides a description of the theme and subtheme alongside direct quotes from the swimmers and the COM-B analysis. Each swimmer has been allocated a number, for example S1 and the location where they swam, for example pool, outdoor or pool and outdoor.

Table 18: Themes and Subthemes

Themes				
1.My back pain journey	2.Learning to swim with back pain	3.How swimming looks for me	4.What I gain from swimming	5.Keep calm and carry-on swimming
Subthemes				
1.How my back pain started	1.My swimming journey	1.Where I swim	1.Relief through swimming	1.My goals and motivation
2.Understanding my back pain	2.How my back feels when I swim	2.My swimming community	2.Swimming improves my physical and mental health and helps me function	2.Developing a swimming habit
3.More than just back pain	3.How I swim with back pain	3.My training regime	3.My feelings about swimming	3.Developing a setback plan and resilience
4.How I manage my back pain	4.My barriers to swimming and how I overcome them			

5.24 Theme 1: My Back Pain Journey

Theme one included four subthemes describing the swimmer's experience of CLBP; see Table 19 and Figure 14.

Table 19: Theme 1: My back pain journey

Theme 1	**Description**		
My back pain journey	Theme describes the swimmers experience of CLBP		
Subtheme	**Description**	**Example**	**COM-B analysis**
How my back pain started	Onset of back pain	*'Historically I have had back issues since about 21, on and off.' (S2 pool swimmer)*	Physical and psychological capability
Understanding my back pain	Understanding of diagnosis	*'And they just said that I have got arthritis in my SI joints and that there is nothing that you can do with it, you have just got to live with it.' (S13 outdoor swimmer)*	Psychological capability
More than just back pain	Symptoms other than pain and the impact on health and life	*'It doesn't manifest itself as pain; I just become very, very weary.' (S7 outdoor swimmer)*	Physical and psychological capability
How I manage my back pain	Conservative, medical, and surgical methods used or used in the past	*'I use ergonomic chairs and an ergonomic mattress at home but not at university and then I also just cut out all hard impact things.' (S11 pool swimmer)*	Physical and psychological capability

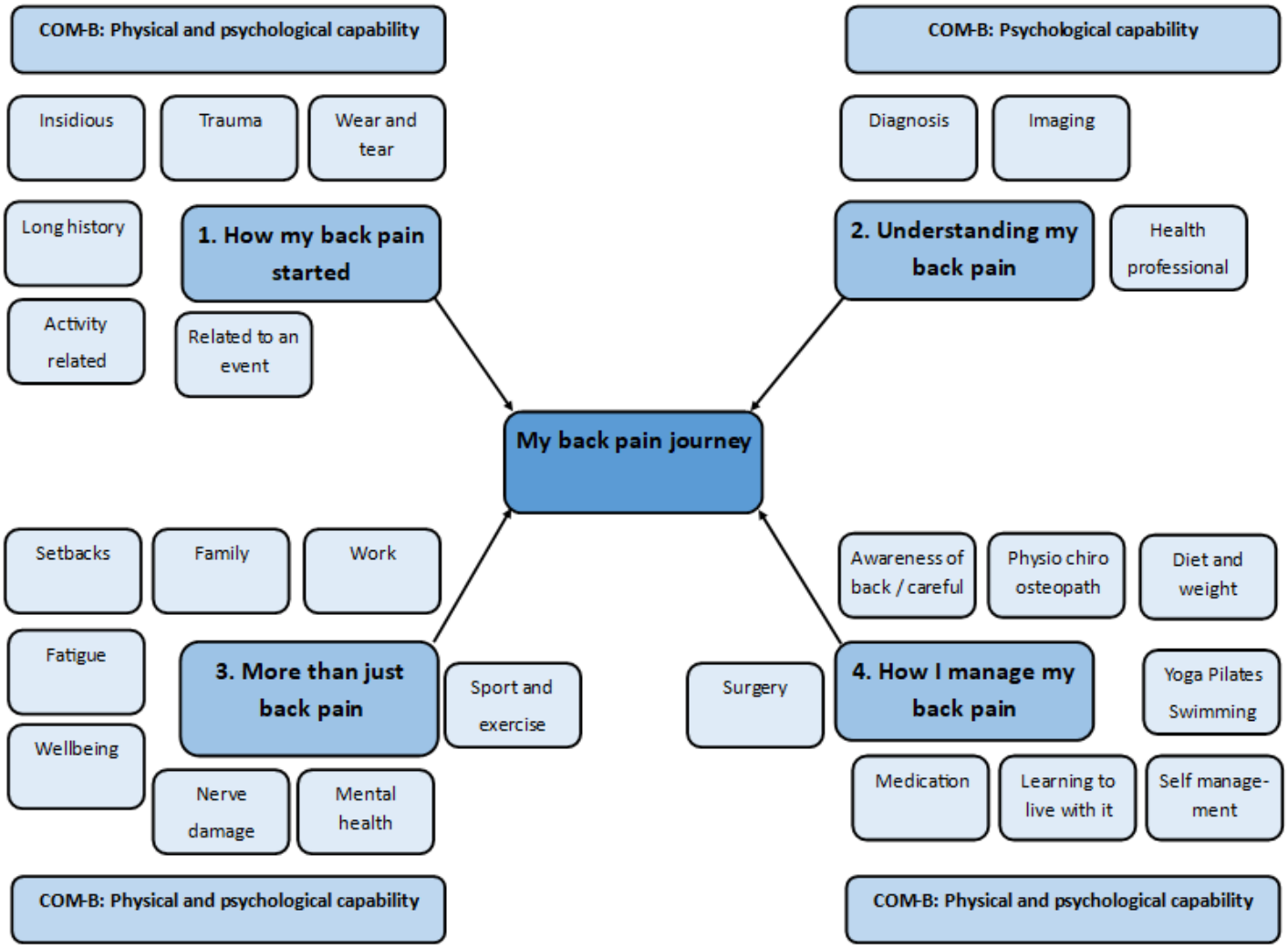

Figure 14: Thematic map: My back pain journey

5.24.1 Subtheme 1: How my back pain started

Each swimmer had a different experience of how their LBP started. Some spoke about how there was a significant injury, for some there were several factors which had contributed, and others couldn't recall an injury, their back condition has developed over time.

'But in 2000 I was involved in a violent struggle, in which obviously I prolapsed one of my discs, I think at L5/S1, it was obviously quite a bad prolapse.' (S7 outdoor swimmer)

'Stupidly climbed on a stool, fell backwards, landed on the corner of the box which is never a good idea and I ended up going to A&E because it was very painful.' (S14 pool swimmer)

5.24.2 Subtheme 2: Understanding my back pain

Some swimmers spoke about diagnostic tests carried out to help determine a structural cause for their back condition and others were unsure of the cause.

'I have had an MRI and I might have some compression of discs but some of it's to do with, I am 48 and some of it's to do with age in your discs, and I think I also expect quite a lot from my body anyway.' (S1 outdoor swimmer)

'We thought originally it was growing pains. Also, because I was doing synchronised swimming, I trained quite a lot; we thought it could just be training but it has now continued on beyond the possibility of it being growing pains or really hard training. And I am not sure what it is. I had a discussion with the physio the other day who thinks it is to do with the QL muscle?' (S11 pool swimmer)

5.24.3 Subtheme 3: More than just back pain

Symptoms varied day to day; most swimmers had baseline symptoms and then times when they experienced a flareup of symptoms. The swimmers spoke about more than just LBP but also loss of mobility, and the impact on family, work, sport, and mental health.

'I am not sure that I have back pain so much as I have discomfort and lack of mobility in my lower back which sometimes manifests as pain if I overdo it... So, most of the time my back is just grumpy.' (S1 outdoor swimmer)

5.24.4 Subtheme 4: How I manage my back pain

The swimmers in this study were all self-managing CLBP. They had tried using many different methods to manage their CLBP; some of these were used early on and others were still used alongside swimming. Conservative management included consulting health professionals, treatments such as manipulation, acupuncture and traction and self-management tools such as exercises, hydrotherapy, Pilates, Yoga, taping heat, cold and dieting. Some swimmers had purchased equipment such as an inverter table and specialist mattresses and chairs.

'I took up fasting 7 years ago and got rid of about 2 ½ stone which seemed to help my back because my posture was better, so I carry on, I do intermittent fasting which I have done for 7 years.' (S7 outdoor swimmer)

'I have got a back-swing traction bed out in the garage that I hang upside down in, so I still do that, took on Pilates as well which has helped.' (S4 pool and outdoor swimmer)

Medical management included consulting the GP and taking medication; most of the swimmers had medication but now managed without unless they were experiencing a setback.

'I used to take a lot of ibuprofen I realised that there is genes involved, but I had taken ibuprofen like it was smarties since 2000 and then I was diagnosed with heart disease and my right artery was almost blocked, so I had a stent put in perhaps 4 years ago, I think. I have stopped taking all pills, all anti-inflammatory pills; I don't touch any pills now. I take an aspirin.' (S7 outdoor swimmer)

Three of the swimmers had undergone surgery for their back and had suffered some degree of nerve damage.

'My lower back I've had 2 ops on, I had to have an emergency decompression, S1, literally my left leg stopped working, never felt any pain or nothing. It just went, and then they went back in and dealt with some scar tissue and sorted out the one above it.' (S6 pool and outdoor swimmer)

5.25 Theme 2: Learning to Swim with Back Pain

Theme two included four subthemes describing how and why the swimmers started swimming and their journey and their experience of swimming with CLBP; see Table 20 and Figure 15.

Table 20: Theme 2: Learning to swim with back pain

Theme 2	**Description**		
Learning to swim with back pain	Theme describes how and why they started swimming and their journey and experience since swimming with CLBP		
Subtheme	**Description**	**Example**	**COM-B analysis**
My swimming journey	How and why, they started using swimming and their swimming background	*'Obviously after I got back pain I couldn't run anymore because the mobility in my left leg, below the knee isn't as good, I have to place the foot, I have to kind of swing it so running is out of the question because I can stumble. And also, it seems to irritate, the impact through my legs irritates my lower back so I took up the swimming as another form of exercise.' (S7 outdoor swimmer)*	Physical and psychological capability Physical and social opportunity
How my back feels when I swim	How being in water helps, how their back feels when swimming, and what adaptations they make when swimming	*'I probably find backstroke is the most relaxing, the least amount of pressure on my back. I don't know if there is any correlation between doing it and helping my back though. But I am also always very comfortable doing free, I never feel it all.' (S11 pool swimmer)*	Physical and psychological capability
How I swim with back pain	How they swim the four strokes, how their back feels swimming these strokes, adaptations, technique, and swimming drills.	*'So, I tend to concentrate on front crawl, that's the one I feel most comfortable with' (S2 pool swimmer)*	Physical and psychological capability
My barriers to swimming and how I overcome them	Barriers to swimming and how they overcome these barriers	*'I have got issues with knees as well, so breaststroke isn't my first choice so I certainly can't do more than probably about 4 lengths of breaststroke because again, it is the position, it does slightly extend my back, so it is pretty much front*	Physical and psychological capability

		crawl and back crawl that I do.' *(S14 pool swimmer)*	

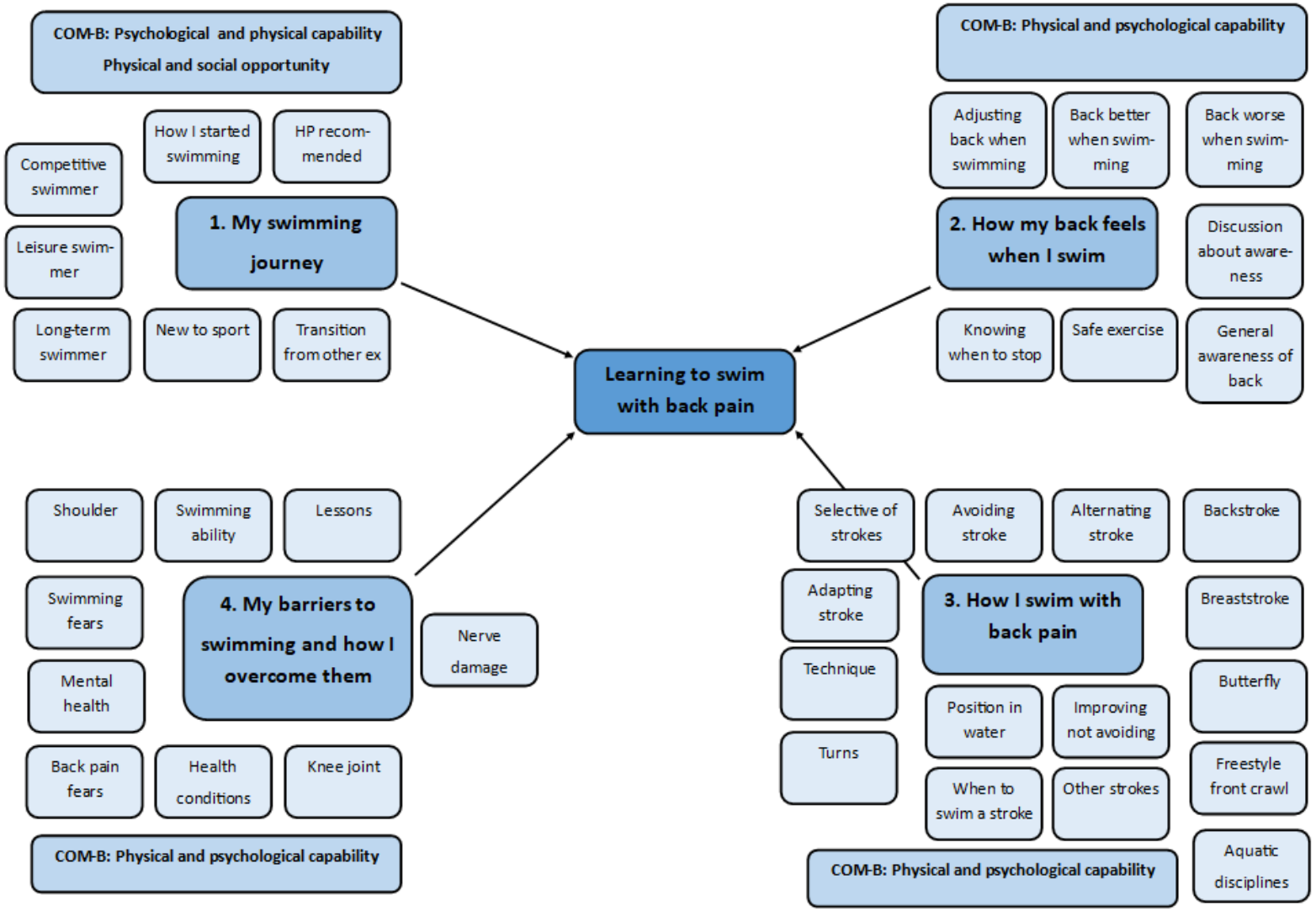

Figure 15: Thematic map: Learning to swim with back pain

5.25.1 Subtheme 1: My swimming journey

Each swimmer shared a different story, describing how and why they started using swimming as a management tool for LBP. Some had been recommended swimming by a health professional, some said that it was an educated choice and others found it was helpful by chance.

'I've always swam on and off growing up. I used to play hockey until my knees took over with that. I have not been able to run since 2000. It was then I had a bone graft on one of my knees and the consultant said you will never run again but you can swim or cycle. So, I tried to get into that a bit and that's how I got into triathlon. And swimming then, I did it for the triathlon. I started open water when I had my knees replaced, as I say it was 14 years in February. I got into open water swimming then after that, because I had them both done at the same time, so it was a big operation and everything. And I needed a challenge, if you like and that was when I got into open water swimming.' (S13 outdoor swimmer)

'It coincided with swimming, a friend of mine, her other half was very much into his swimming, an iron man and all that, very unassuming chap and one day we thought we would jump in the water and see what on earth all the fuss was about. And we had such fun together, me and my friend, we absolutely just didn't stop laughing all the way round and we thought my god if this is what this can give us. We are just normal bobbing swimmers, we didn't really do anything like front crawl then, we just thought this was brilliant, we loved it so much. But how we felt when we got out the water and then for the rest of the day it was such a journey. We thought surely other people will want to do this; this is crazy, why has anyone not told us about this before? It was like the best kept secret.' (S9 outdoor swimmer)

Some of the swimmers had always swum and were ex-competitive or current competitive swimmers.

'I learned to swim when I was 4 until 11 just in swim classes; I then stopped swimming but did synchronised swimming from 11 until 16. And then switched to water polo and actual swimming, from 16 to 18. And now I am doing water polo but swimming in lanes as well.' (S11 pool swimmer)

'I swum as a child; I swam at nearly pro level.' (S5 pool and outdoor swimmer)

Some swimmers had only swum occasionally for leisure.

'I swam as a kid; swim in the sea every so often but not as a form of exercise.' (S1 outdoor swimmer)

'No, not really no nothing at all, just on holiday really or I would go in the pool with the kids when it was warm. I am not really a very strong confident swimmer. For me to get in the water was a feat by itself, I wouldn't get my hair wet, and I wasn't really keen on going out of the water.' (S9 outdoor swimmer)

For others swimming was a transition from other exercise they could no longer manage.

'I can't run anymore, if I only do cycling that doesn't work for my back, because it's one form of exercise, it's good for my head, it's fun, I like it and it's also a challenge.' (S1 outdoor swimmer)

'I used to do a lot of road running and as I got older I started getting Achilles tendon problems so I thought in the meantime while I am waiting for this to heal I would get out and do some swimming hence I took out a membership ultimately at the leisure centre and the swimming took over from the running so I left the running off and carried on with the swimming and I then joined a club and it just escalated from there.' (S4 pool and outdoor swimmer)

5.25.2 Subtheme 2: How my back feels when I swim

The swimmers spoke about how the water provided support, stability, and a safe environment in which to exercise.

'It just felt like that kind of support of being held in the water that really seemed to make it a lot easier and the pain.' (S10 outdoor swimmer)

'For me its common sense, you are in the water so therefore you're buoyant and the stress of gravity and all that kind of stuff is taken away.' (S2 pool swimmer)

The swimmers were aware of how their back felt whilst swimming, some sensations were deemed comfortable and others uncomfortable or painful. For the former words such as

lengthen and stretch were used and for the later pressure, tighten, compression, pull, pivot, extend, flex and arch were used.

'So, for my back the one that I am consciously trying to do is front crawl but only using my arms, which I do not know whether it is right or wrong, but it means that I am just lengthening in the water all the time.' (S1 outdoor swimmer)

'Breaststroke used to be the stroke I was strongest at, now I am conscious with the breaststroke it causes some compression of my lower spine, and I am wary. I don't have a vigorous kick anymore. I normally do front crawl, that doesn't cause any problems. Backstroke, I'm aware that there is more pressure on my lower spine when I kick, presumably because that's me trying to keep my centre up so front crawl I would say is the stroke that I would say I favour but I try and do all three as a balance.' (S7 outdoor swimmer)

Although the swimmers sometimes spoke about discomfort, they followed this by discussing how they adapted their stroke or choice of stroke to reduce or eliminate these sensations.

'But the whole action of breaststroke I don't think lends itself to back pain either really, I don't find it as… you are on a level when you are doing crawl, whereas I find it flexing my back a bit too much, breaststroke. I would prefer not to do that because of my back as well. So, I find if I can position myself right and my pelvis properly that helps with the pain as well you see when I am swimming.' (S13 outdoor swimmer)

'I swim about 3km each time I go in, I will almost lift my lower back and drop my legs because after a while if I do get in the same position for too long and relaxed, I do tend to arch and that, it doesn't necessarily cause pain, but it is just uncomfortable. I don't tend to do much breaststroke. I have got issues with knees as well, so breaststroke isn't my first choice so I certainly can't do more than probably about 4 lengths of breaststroke because again, it is the position, it does slightly extend my back, so it is pretty much front crawl and back crawl that I do.' (S14 pool swimmer)

5.25.3 Subtheme 3: How I swim with back pain

5.25.31 Front crawl / Freestyle

Front crawl was the most popular stroke for the swimmers and for most swimmers it was the most comfortable stroke for their back.

'I am also always very comfortable doing free, I never feel it at all.' (S11 pool swimmer)

One of the long-term swimmers found that initially after her injury front crawl increased her pain and she had to stick to backstroke. Since modifying her position, by lifting her back and dropping her legs in the water she was now able to do both backstroke and front crawl unless she is having a bad day.

'With the initial injury it (front crawl) actually made it a bit worse. I found that the position that I was in in the water when swimming on my front wasn't good.' (S14 pool swimmer)

Most of the swimmers did not have to adapt front crawl. A couple of swimmers felt that front crawl imitated traction and they felt the stroke helped lengthen their spine; one swimmer had found that not kicking but using her arms helped enhance this feeling.

'I feel that swimming front crawl, imitates to a degree the traction sessions that I have had in the past, which proved so successful. Front crawl also helped with the stiffness in my back because of the rotation action required.' (S4 pool and outdoor swimmer)

The less able swimmers spoke about taking lessons to learn how to swim front crawl correctly, learning how to breathe correctly and gaining confidence putting their face in the water.

'I took lessons to improve my swimming. I have never been able to front crawl or anything like that so I can do that now, I put my head under the water when I swim. I do it all correctly now. It is an achievement for me at my age.' (S8 pool swimmer)

The two swimmers that swam head up front crawl for water polo mentioned that this position could put '*pressure on the lower back*'.

'Other than that, I often find if I am doing water polo head up, if I am trying to do head up swimming that will strain my back a little bit.' (S11 pool swimmer)

One of the experienced swimmers had been having difficulty swimming just front crawl; she had received some coaching with video feedback. After making some adjustments to her head position so that she was looking diagonally forwards and changing her breathing technique she felt she was straighter, '*less humped over'* and was physically more comfortable doing the stroke.

'He (the coach) has changed my head position and I wonder if that has helped with the discomfort, the pain but the fact that I can swim for longer on front crawl. And I had thought that it was just the breathing but now I am thinking about it in relation to this maybe I am physically more comfortable doing it. That the way I breathe and where my head is different, and I am less humped over.' (S3 pool swimmer)

The swimmers spoke about how certain front crawl swimming drills were helpful for their back; these included only using their arms, catchup, ripple, 6 kick roll, single arm drills and kicking drills. For one swimmer drills added variety to the session and others felt that they didn't have time for drills, the ex-competitive swimmers were more familiar with drills.

'So, catch up drills and ripple, where you run your fingers across the water. Yes, anything freestyle wise I have found good. The good thing about the catchup drills is you are stretching forwards, you are stretching; I have found that helps loosen up the back because you are stretching the sides, potentially. When you are in pain you tend to tighten everything up, you hold everything in a little bit, so that kind of drill helps loosen everything up a bit.' (S2 pool swimmer)

5.25.32 Backstroke

Some of the more experienced pool swimmers felt that backstroke was the most comfortable stroke for their back.

'I probably find backstroke the most relaxing, the least amount of pressure on my back.' (S11 pool swimmer)

'The only way that I could swim comfortably was on my back, rather any sort of extension in my lower back, If my back is bad, I would probably have to stick to just backcrawl.' (S14 pool swimmer)

The older version of backstroke, known as elementary or old English backstroke was mentioned by one of the swimmers; she had found it a helpful form of the stroke for stretching her back.

'Double armed backstroke, old English backstroke. If I am really stiff then I will do that as well, not just normal backstroke. Like when I do my stand up double armed stretch, I can get them back as far as I possibly can. And the weight of your legs sort of almost helps the stretch on your back. So, a big kick ad a massive glide and try and get those back as far as I can. For however many lengths it takes.' (S3 pool swimmer)

Backstroke was not practiced by some of the outdoor swimmers; this was partly due to sighting difficulties and partly due to lack of confidence. One outdoor swimmer commented that she felt dizzy when on her back because there was nothing to fix on.

'I only tried backstroke in June when I started swimming in the sea and I didn't get on with it, and I don't know why…I actually found it quite hard work on my arms I might be able to try it again, I also found that I got dizzy quicker, it was more disorientating because you have nothing to fix on.' (S1 outdoor swimmer)

One of the outdoor swimmer did swim backstroke but he was swimming in a tidal pool and tended to alternate backstroke with front crawl; he commented that when swimming backstroke he felt there was more pressure on his lower spine when he kicked and was trying to keep his centre up.

'Backstroke, I'm aware that there is more pressure on my lower spine when I kick, presumably because that's me trying to keep my centre up.' (S7 outdoor swimmer)

5.25.33 Breaststroke

Some of the swimmers mentioned that they had had been advised against swimming breaststroke.

'But I was told never to do breaststroke and I have never ever been able to do breaststroke.' (S6 pool and outdoor swimmer)

One of the outdoor swimmers had lessons to improve her technique, so that she was able to go down into the water and up, this was helpful.

'I had a couple of lessons with a teacher, near Bodium in the river, and she was teaching me a better breaststroke. So really going down into the water and up and she was saying if you are swimming above the water the whole time it is really bad for you, it will strain your back so yes, I would say that I am quite careful about really following, I have her words in my mind that I really focus on my stroke.' (S10 outdoor swimmer)

Another swimmer had never been able to master the breaststroke despite having lessons. Swimmers mentioned that the breaststroke can put either pressure or compression or '*pull*' in the lower back. Some said that breaststroke extended or flexed their back.

'So, with breaststroke, if I do a lot of breaststroke, I find it pulls on the bottom of my back.' (S2 pool swimmer)

One swimmer avoided breaststroke if she was having a flare-up, and another would only do it later in a session. One of the experienced swimmers said that the core of the body needed to be strong to do breaststroke over a long distance.

'So, the core of the body in a breaststroke, it really needs to be strong to carry on breaststroke for a long distance.' (S5 pool and outdoor swimmer)

One swimmer said that a breaststroke kicking drill was helpful for his back, particularly when underwater as he was able to keep in a more horizontal position and he said that the symmetry of the kick was beneficial. Some of the swimmers who swam breaststroke alternated it with other strokes. Only two of the swimmers, one pool and the other an outdoor swimmer said that breaststroke was their preferred stroke.

'Breaststroke, Front crawl, that doesn't affect me but with breaststroke you have to be careful with your knee. Breaststroke is my strongest one. Front crawl I focus more on the breathing, it is the difficult one to coincide everything. Breaststroke is my main strength.' (S8 pool swimmer)

Swimmers with knee pain tended to avoid breaststroke.

'So, breaststroke leg kick, I find I like the leg kick and as long as I keep myself in a horizontal position. So, there is a drill we do, 3 kicks up on the water and 3 kicks under the water and that's a nice drill for me, you dive down and because you are not trying to keep your head above the water, you can keep yourself in a more horizontal plane and therefore that helps. And it is just nice; I am liking the breaststroke leg kick for the symmetry and the feel of the power. I just enjoy that drill.' (S2 pool swimmer)

5.25.34 Butterfly

Very few swimmers swam butterfly, it was only discussed by the long-term, ex-competitive swimmers. Some swimmers had not learned the stroke or ever wanted to learn the stroke.

'Butterfly, I have never ever been able to do that, I have never really wanted to, to be honest.' (S8 pool swimmer)

The arch during butterfly was mentioned by one of the swimmers as problematic and others said that their back didn't have enough flexibility.

'And butterfly obviously is quite a big arch on my back.' (S12 pool swimmer)

'But my back wouldn't be flexible enough to take the fly, so I have learned to leave that.' (S4 pool and outdoor swimmer)

The swimmers didn't swim fly early in the set or for too long and avoided the stroke if they were having a bad day; for some swimmers fly was always avoided.

'But some days I just can't, I haven't got the flexibility in there that day, for whatever reason it is, if I haven't warmed up properly or it is too cold.' (S3 pool swimmer)

One swimmer commented that doing a fly kick on his back as a drill felt good.

'*And I even find butterfly kicking on my back quite good.' (S2 pool swimmer)*

5.25.35 Alternating strokes

Some of the more able swimmers discussed swimming sets and how often they would change stroke. One outdoor swimmer found that she had to switch from her preferred stroke breaststroke to backstroke to have a break from the pressure on her back, she was just

starting lessons to improve her technique. Another outdoor swimmers spoke about how doing three strokes was good for balance.

'So front crawl I would say is the stroke that I would say I favour but I try and do all three as a balance. I normally warm up and do 2 lengths of front crawl and after that I do ½ a length of breaststroke and then go on to the front crawl and then repeat. I then may reach the side, do ½ length backstroke and then go onto front crawl (swimming in large tidal pool).' (S7 outdoor swimmer)

One pool swimmer found that it was better for her back to stick to one stroke, but she switched stroke to avoid getting bored.

'Physically I find it better to stick to one (stroke) but mentally I get bored of doing just one.' (S12 pool swimmer)

5.25.4 Subtheme 4: My barriers to swimming and how I overcome them

The less able swimmers discussed gaps in swimming ability and skills and the desire to take lessons, improve technique and overcome swimming fears such as putting their face in the water.

'Because I still have a bit of a phobia of being claustrophobic in the water. So, I am constantly overcoming lots and lots of fears. And even at my age, thinking gosh if I can do this, I can do anything and even with the problems that I have incurred throughout my life I feel like completely like a different person in the water.' (S9 outdoor swimmer)

Swimmers spoke about comorbidities and how this impacted their choice of swimming stroke. The most common comorbidity was a knee condition, and this stopped them swimming breaststroke. Three of the swimmers had nerve damage due to their back condition and this had resulted in weakness, and they had to adapt how they swam.

'When I was getting really bad with my knees, before I had them replaced, because I have got OA so it just got gradually worse and worse and I learned to do freestyle, I couldn't do breaststroke because of my knees. It hurt too much so I learned to do freestyle so that's all I do really, crawl.' (S13 outdoor swimmer)

5.26 Theme 3: How Swimming Looks for me

Theme three include three subthemes which describe an average swim for the swimmers, describing where they swam, how they trained and whether they were swimming alone or with a group; see Table 21 and Figure 16.

Table 21: Theme 3: How swimming looks for me

Theme 3	**Description**		
How swimming looks for me	Theme describes an average swim for the swimmers; where they swam, how they trained and whether they were swimming alone or with a group		
Subtheme	**Description**	**Example**	**COM-B analysis**
Where I swim	The location where they swam, pool or outdoors and the advantages and disadvantages of these locations.	*'But some days I just can't, I haven't got the flexibility in there that day, for whatever reason it is, if I haven't warmed up properly or it is too cold. So, the water temperature makes a humungous difference to me.' (S3 pool swimmer)*	Physical opportunity
My swimming community	Swimming community supporting swimmers, for example clubs, or informal groups and the impact of swimming in a group	*'The social aspect, we get out and we have cake and a hot drink, and we sit and look after each other on the after drop, we make sure that everyone is safe; if they are driving or walking home and we are not catching hypothermia, that's a big thing. I have never looked forward to a winter so much as I have now.' (S9 outdoor swimmer)*	Social opportunity
My training regime	Training regime and methods including warmups, content of swimming sessions and dose of swimming	*'I train with an apple watch so that does my lengths, tracks the time and I keep all my stats on Strava… It certainly was during my charity swim; it is quite nice to be able to see.' (S14 pool swimmer)*	Physical and psychological capability Physical and social opportunity

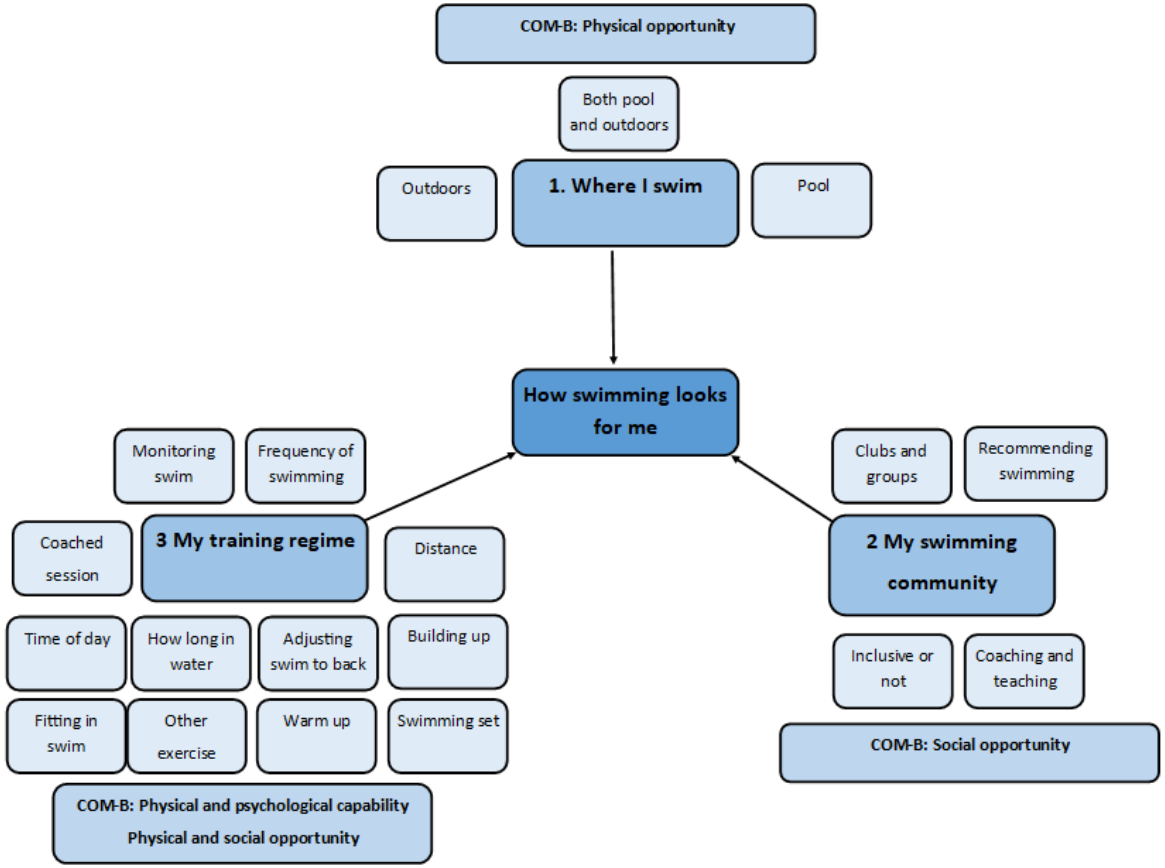

Figure 16: Thematic map: How swimming looks for me

5.26.1 Subtheme 1: Where I swim

The swimmers in this study swam in several locations including pools, the sea, tidal pools, harbours, rivers, lakes, and quarries. Some swimmers swam both indoors and outdoors and some only swam in one location; the advantages and disadvantages of these locations were discussed.

One pool swimmer felt that the pool was better as her back was worse in colder water.

'But some days I just can't, I haven't got the flexibility in there that day, for whatever reason it is, if I haven't warmed up properly or it is too cold. So, the water temperature makes a humungous difference to me.' (S3 pool swimmer)

Most of the less able swimmers reported the pool was better when learning new skills.

'And I thought why can't I breathe anymore and then I tried it in the pool to see if I was more confident in the pool because if it goes wrong in the pool, you just stand up and breathe but if it goes wrong in the sea there is less room for, so I don't try things so much in the sea.' (S1 outdoor swimmer)

One of the outdoor swimmers stopped swimming in the pool as he had more LBP crouching in the shallow end and pushing off the side.

'One of the reasons why I started to step away from swimming was because I am over 6ft, but I guess this applies to anybody, in swimming unless the pool is really heated you know really hot, you crouch in the shallow end, but that action hurts my lower back. So, when I swim, when you stop, when you do a length, you reach the shallow end and then you crouch down, that action will be painful, that used to put me off. The other issue was when swimming lengths when you get to the deep or the shallow end and you turn, normally you are in the lane and there are other people swimming. Most people push off; they might not have both feet aligned on the wall and push because they don't have that luxury. Well for me that would cause a lot of pain because you push off perhaps with one leg being slightly out of alignment from the other.' (S7 outdoor swimmer)

Another outdoor swimmer felt that the pool was an intimidating place due to the faster swimmers and she had a sore throat after swimming in a pool due to the chlorine. The outdoor swimmers discussed the advantages of swimming outdoors; these included that there was no cost, you could swim when you wanted, there was more space, it was more refreshing, less boring, and more enjoyable. Some swimmers spoke about encounters with wildlife whilst swimming and that the colder water had additional benefits for pain and mood.

'In the river we saw a Kingfisher the other day and all the lovely extras you have that you would never have in the pool.' (S10 outdoor swimmer)

The negative problems relating to swimming outdoors included having to check the weather and sea conditions and the time limits due to the cold. The swimmers appeared to have a good knowledge of their open water location, such as the harbour being a more protected area to swim and how to deal with warming up after the swim. Concern was raised for the safety of new swimmers starting open water swimming; outdoor swimmers spoke about looking out for other swimmers.

'We are constantly weather watching what's going on if it's safe or not. Yes, I don't think about anything else apart from getting in the sea. If my back is really bad, I don't really care if it is minus whatever I have swum in the sea even if it is 5 or 6 degrees, I love it.' (S9 outdoor swimmer)

5.26.2 Subtheme 2: My swimming community

Some of the swimmers swam with clubs or informal groups; these provided support for the swimmers. For the outdoor swimmers the support groups were important from a social point of view but also for safety. One outdoor swimmer spoke about a charity that she volunteered for called mental health swims. It allows people to meet up with other swimmers helping make the swim safer and providing social support. The pool swimmers did not discuss this experience, presumably because it was the lifeguard's responsibility to keep the swimmers safe and the risks were less.

'I have really enjoyed swimming with others and the group that we have formed now is just such a lovely combination of people, it is really nice to sit and chat afterwards. I am seeing people grow in confidence; we had a lady who was literally in tears, saying I just cannot do

that. I think because I know how tough it is to build that confidence, I have been really gentle, saying there absolutely is no pressure, I am here to help you in, I can help you out. And just taking things really slowly and it is has been really rewarding to see people saying oh my god I never thought I could do this and now it is a real plus during my week. And they come back to following week and they have bought some shoes and some gloves, and they have got their hat and it is just really nice to see people evolving and going on that journey.' (S10 outdoor swimmer)

The outdoor swimmers spoke about how swimming can be inclusive, but this is not always the case. There were mixed views with regards to swimming being inclusive; one of the swimmers that swam both in the pool and outdoors felt that all body types could swim so it would be inclusive. Another outdoor swimmer spoke about feeling '*intimidated by super-fast swimmers*' in the pool and would avoid the pool for this reason. Outdoor swimming seemed more inclusive than the pool swimming and the outdoor swimmers seemed more aware of the issue of inclusivity.

'I am not a massive fan of swimming pools and I always just get a really sore throat after swimming in a swimming pool, you know that kind of heavy chlorine. I always felt intimidated but super-fast swimmers, you know the lanes, and the tumble turns. I was in the slower lane, so I think that is another reason why I turned to the open water because it seemed like a lot less stress going there.' (S10 outdoor swimmer)

'And the lovely thing is, even though these guys are like way above me in their levels of fitness I still feel like we are all in it together, we are all the same level. Nobody ever feels like you are better than me or I am better than you or you are a bit rubbish because you can't do this, or you can't do that. Nobody is excluded we are all welcome, no one gets left behind.' (S9 outdoor swimmer)

One outdoor swimmer spoke about the process that she took to '*enter that world*' in becoming a swimmer because she had not been involved in sport as a child.

'We weren't a super sporty family, so I grew up thinking it wasn't really my world and I think that is what swimming has really taught me is to, certainly that was why I really went up to the Serpentine that year, just to observe things, see how things work and choosing a wetsuit

and all those things, although I don't use a wetsuit now. Just those things that kind of enable you to enter that world. And that is what has been great about mental health swims is now I can see people that they didn't think it was their thing either, that they could be seen as someone who can have that in their lives, and it is a really nice transition to help people make I think.' (S10 outdoor swimmer)

The outdoor swimmers spoke about how they liked to recommend swimming to others with LBP.

'I would always recommend it to people because I do it, but there is not enough done in that respect I don't think. No disrespect, I mean my sister is a physio, I have even come across a lot of physios who do not do any exercise so I think people need to make it out that it is fine, and it should be the norm rather than being a chore to do it, that's the thing, give it a try sort of thing. But I always if anyone has back pain, I say try and have a swim, you will feel better for it.' (S13 outdoor swimmer)

5.26.3 Subtheme 3: My training regime

The ex-competitive swimmers and to some degree the less able swimmers spoke about the different aspects training they used when swimming, however only the ex-competitive swimmers referred to it directly as training. Training methods used included aerobic, anaerobic (ex-competitive / current competitive swimmers only), specific skill and technique, flexibility, core strength exercises and cross training. The swimmers discussed building up, easing off and monitoring progress through devices and diaries.

'Because of COVID, I have gone back 6 weeks now, so I could only do 10, then I do 20 and I have increased you see. I have increased that strength and then I get stronger, as time goes. I was doing over 100 lengths before COVID.' (S8 pool swimmer)

'I train with an apple watch so that does my lengths, tracks the time and I keep all my stats on Strava… It certainly was during my charity swim; it is quite nice to be able to see. Also, the tracking of fitness levels and times and everything like that; it is all in one place so I can do it straight from my app on my phone. With Strava I was able to map it with lots of other things that I was doing. So was I working harder on my bike or walking or whatever.' (S14 pool swimmer)

Only the ex-competitive swimmers in this study did a land-based warm up prior to swimming. For a water-based warmup it was common to start off slowly in the pool at a slower pace with a certain stroke or stroke combination. One early morning swimmer had to do a land-based warmup before swimming as her back was stiffer in the morning after sleeping.

'I warm up my back before swimming. At home I roll my legs side to side and practice the cat cow stretch and when I get to the pool, I warm up my shoulder.' (S4 pool and outdoor swimmer)

'I tend to do it all in the water. So, I will do a gentle warm-up of about 8-10 lengths…I find that I get better movement in the water. So, I find it more comfortable doing stretches in the water.' (S12 pool swimmer)

Swimmers who didn't do a land-based warmup reflected that maybe they should do one and others did not have the time, or they lacked confidence. Although many swimmers were not doing a land-based warmup just before swimming, they did engage in stretching and strengthening programs during the week, including Yoga and Pilates, this was another tool to help manage their back condition.

'No, Should, no I don't really. Often it is fitting a swim in around everything else, because I have switched priorities, I make sure that I get that swim… So often it is time efficient, so I just get in.' (S10 outdoor swimmer)

The '*dose*' of swimming was also discussed, including the time in the water, distance swum and swim frequency. This varied considerably; outdoor swimmers swam more frequently but often for less time, presumably due to the cold, but possibly because they didn't have to book a session at the pool. One swimmer was training to swim the English Channel and he swam 5-6 times a week for an hour and another competitive pool swimmer also swam that frequently. Two of the pool swimmers would have liked to swim more frequently but their working hours, shift cycles limited when they could swim. One swimmer spoke about how swim is now non-negotiable, everything must work around her exercising.

'I try if I can, I would say about 5 days out of 7.' (S9 outdoor swimmer)

'At the moment I go 4 or 5 mornings, and it is about 40 minutes and Wednesday evening for an hour.' (S3 pool swimmer)

'I try and swim at least once or twice a week. And up to an hour really.' (S13 outdoor swimmer)

5.27 Theme 4: What I Gain from Swimming

Theme four included three subthemes describing therapeutic benefits gained from swimming; see Table 22 and Figure 17.

Table 22: Theme 4: What I gain from swimming

Theme 4	**Description**		
What I gain from swimming	The therapeutic benefits gained from swimming		
Subtheme	**Description**	**Example**	**COM-B analysis**
Relief through swimming	Relief from symptoms experienced through swimming	*'It does give me relief; I always feel better after I have swum' (S13 outdoor swimmer)*	Automatic and reflective motivation
Swimming improves my physical and mental health and helps me function	Physical, mental health and functional benefits gained through swimming	*'I found that the weight dropped off me, everyone was telling me how ill I looked but I felt a million dollars, it is the best I have ever felt. The back pain disappeared completely' (S4 pool and outdoor swimmer)*	Automatic and reflective motivation
My feelings about swimming	Feelings about swimming	*'I would always recommend it to people because I do it, but there is not enough done in that respect I don't think' (S13 outdoor swimmer)*	Automatic and reflective motivation

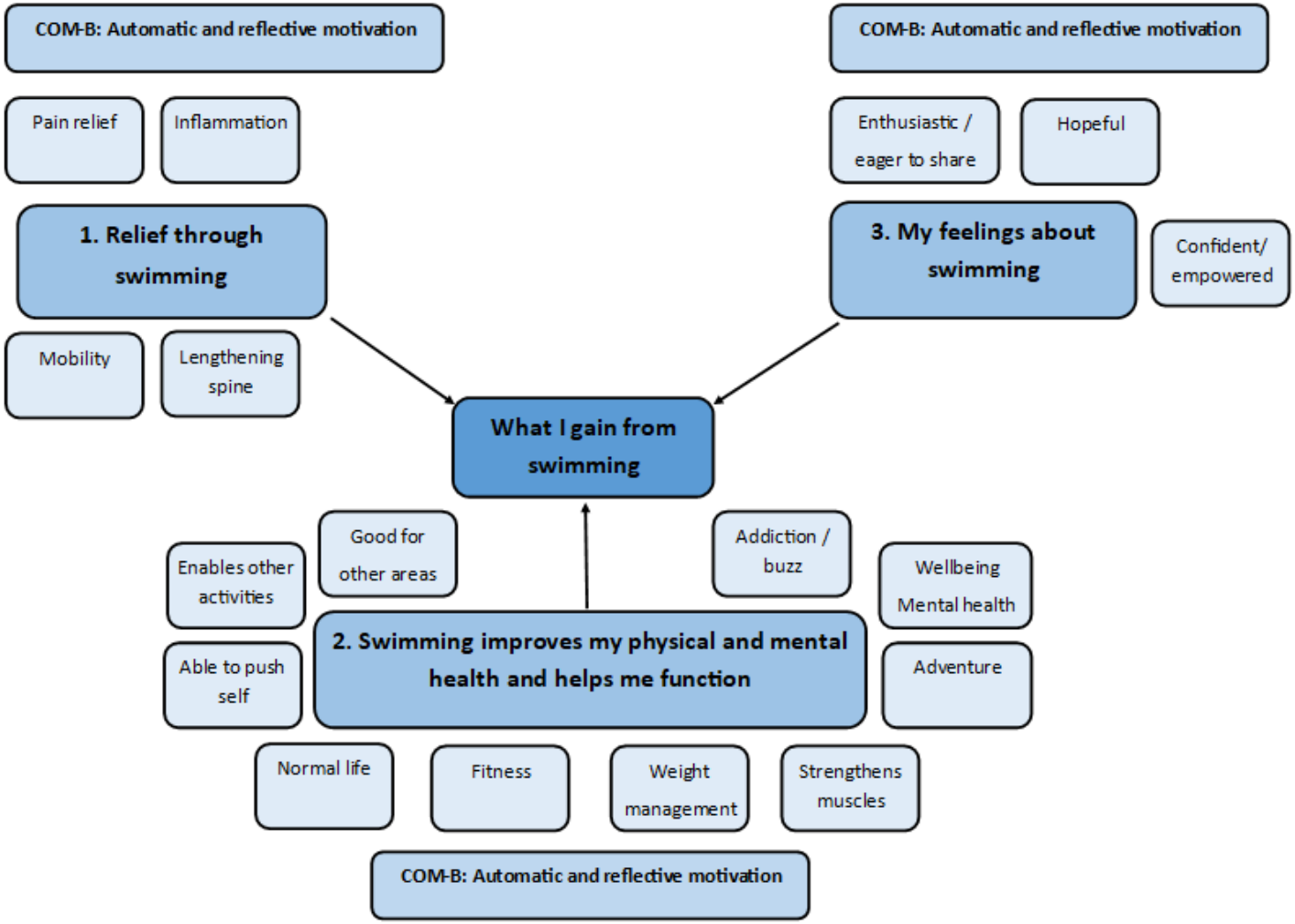

Figure 17: Thematic map: What I gain from swimming

5.27.1 Subtheme 1: Relief through swimming

When describing the impact of swimming on symptoms, the swimmers often used the word *'relief*'.

'Swimming has definitely helped my back pain, bringing relief, enabling me to lead a normal life and not require me to have further operations on my back.' (S4 pool and outdoor swimmer)

'I have found that just a swimming pool swim relieved the pain in the back.' (S5 pool and outdoor swimmer)

The additional benefits of cold-water swimming were discussed by the outdoor swimmers.

'But I have just found that swimming is absolutely the thing that helps the most, especially the cold, especially the cold-water swimming.' (S10 outdoor swimmer)

The swimmers reported feeling more mobile after swimming.

'But I realised I am more mobile; my back is much more supple.' (S7 outdoor swimmer)

The swimming "helps my mobility and core strength" (S3 pool swimmer)

They also spoke about how they felt their body grow after swimming and that swimming had similar effects to a session of traction.

'I grew again and as much for your lower back as your upper back.' (S6 pool and outdoor swimmer)

'I feel that swimming front crawl imitates to a degree the traction sessions that I have had in the past which proved so successful.' (S4 pool and outdoor swimmer)

5.27.2 Subtheme 2: Swimming improves my physical and mental health and helps me function

The swimmers spoke about how swimming had helped them lose weight and maintain a healthy weight.

'Swimming helps to keep the weight off her (lower tummy) and that seems, even if it is a subconscious thing makes me think that my back is not so bad.' (S3 pool swimmer)

'I have lost over a stone just from swimming.' (S14 pool swimmer)

Other physical benefits reported by the swimmers included improvement muscles strength and fitness.

'I think the swimming does improve the strength in your back, as well as your hip and your knee and your upper strength as well.' (S8 pool swimmer)

'So, it all about just keeping my fitness up, keeping my stamina up, because that is something you lose quite quickly, it's knowing that if I wanted to swim 3K I could got out and swim 3K, I have got that ability to do that.' (S2 pool swimmer)

The swimmers discussed how they had found swimming beneficial for their mental health.

'It's good for my head.' (S1 outdoor swimmer)

'It's my headspace' (S8 pool swimmer)

Some swimmers spoke about how swimming enabled them to do more and lead a normal life.

'Swimming has definitely helped my back pain, bringing relief, enabling me to lead a normal life, and not require me to have further operations on my back.' (S4 pool an outdoor swimmer)

'Just coming to the sea first thing in the morning to swim and open your back up a bit beforehand meant that I then could do all the gardening, so then the swimming starts to enable other stuff.' (S1 outdoor swimmer)

5.27.3 Subtheme 3: My feelings about swimming

The words the swimmers used during the interviews conveyed how their feelings about swimming. This included feeling confident, empowered, enthusiastic, hopeful, and eager to share.

'I am constantly overcoming lots and lots of fears. And even at my age, thinking gosh if I can do this, I can do anything and even with the problems that I have incurred throughout my life I feel like completely like a different person in the water.' (S9 outdoor swimmer)

5.28 Theme 5: Keep Calm and Carry-on Swimming

Theme five included three subthemes describing the strategies the swimmers used to enable regular swimming; see Table 23 and Figure 18.

Table 23: Theme 5: Keep calm and carry-on swimming

Theme 5	**Description**		
Keep calm and carry-on swimming	Strategies to enable regular swimming.		
Subtheme	**Description**	**Example**	**COM-B analysis**
My goals and motivation	Setting goals, challenges, and other sources of motivation	*'So, it all about just keeping my fitness up, keeping my stamina up, because that is something you lose quite quickly, it's knowing that if I wanted to swim 3K I could swim 3K, I have got that ability to do that.' (S2 pool swimmer)*	Reflective and automatic motivation
Developing a swimming habit	Swimming regularly and developing an exercise habit	*'I think it is just part of my life to be honest. Even when I had my children or had my operations on my knees and my shoulders, I can't imagine not doing it. You know you talk to people, and they say I have not been to the gym in 6 weeks, and I say have you been ill? It's just part of my life.' (S13 pool swimmer)*	Reflective and automatic motivation
Developing a setback plan and resilience	Setback plan for flare ups and developing resilience	*'So, a lot of the times where before I would have gone, I can't do anything today, my back has gone, I have put my back out, I would have to have taken medication and probably the heat /cold on it. I would actually now, I don't do any of that I just get back in the sea.' (S9 outdoor swimmer)*	Psychological capability

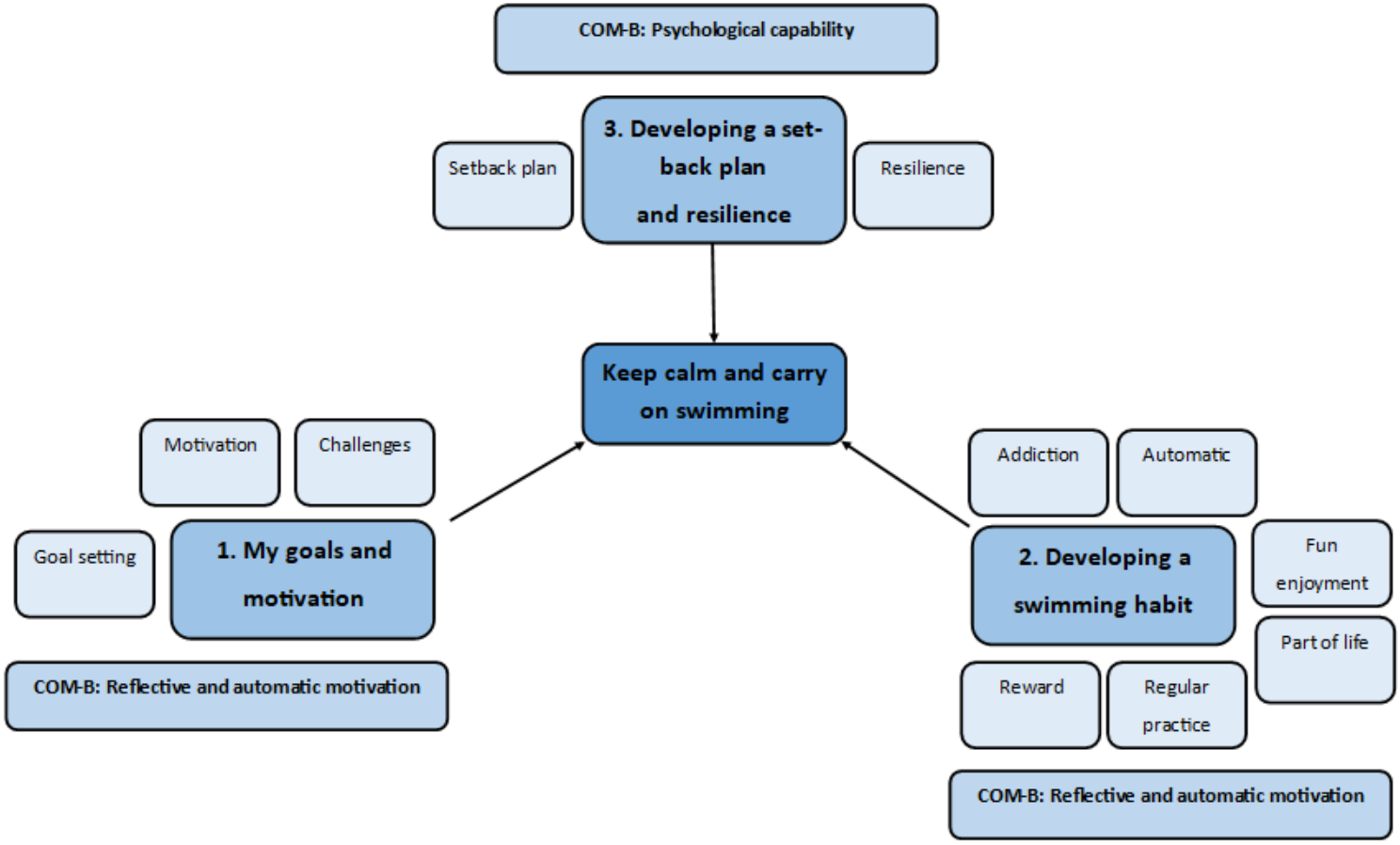

Figure 18: Thematic map: Keep calm and carry on swimming

5.28.1 Subtheme 1: My goals and motivation

Some swimmers spoke about setting goals and signing up for challenges.

'My aim, I can only do a length in 35 seconds, but I want to be quicker.' (S8 pool swimmer)

'I always need something, when I started swimming in the pool because I did open water swimming as well that was great just swimming up and down but that wasn't enough, so I got a wetsuit and carried on and did open water competitions, I always need that goal. And I knew if I was going to do indoor swimming I was going to have to compete at the masters, I knew I would have to have a goal to measure myself by and all my sports have been the same.' (S4 pool and outdoor swimmer)

Other sources of motivation included wanting to maintain a healthy weight, feeling more mobile, having less pain, improvements in fitness, a feeling of achievement, to improve wellbeing and to keep mobile for the future.

'I think for my wellbeing, it's an achievement and I think when you come out, at least you have done something rather than nothing. That's what I think in life anyway, at least you have tried. And you are doing something rather than feeling sorry for yourself. It keeps you going. It makes you feel good afterwards and it is better than nothing.' (S8 pool swimmer)

'Just I know, I haven't got a lot of weight to lose, but I know that if I lose another stone maybe it will take the pressure off my knees and the pressure off my back, and I think it is just that sort of thing that keeps me going.' (S10 outdoor swimmer)

Two of the swimmers spoke about the fear of a less active future.

'I am aware enough that what I am doing is going to impact and I am conscious that I don't want to end up 80 and not able to move. You have to keep it going now. There is no point giving up.' (S1 outdoor swimmer)

'Obviously, the sporty side of it, the competitive side of it but general fitness, keeping the weight off but also keeping my mobility in my back because I know I do seize up if I don't go.' (S3 pool swimmer)

One of the outdoor swimmers spoke about group motivation also being important source of motivation.

'We are very motivated as a group; we are really about self-care and the care of others.' (S9 outdoor swimmer)

5.28.2 Subtheme 2: Developing a swimming habit

The swimmers all swam regularly and had developed an exercise habit; going swimming had become automatic and exercise was part of life. What was common in the interviews was everyone was swimming weekly and the language they used indicated that they had accepted that this was going to be part of their self-management plan.

'I stretch, if not every day, then every second day, I do mobilisation exercises every day. And I walk every second day as in fast / slow walking.' (S7 outdoor swimmer)

The frequency that the swimmers swam varied considerably and depended on factors such as where they swam and other commitments such as work.

'I go in everyday, probably for about 15 minutes.' (S10 outdoor swimmer)

The swimmers spoke about the chemical reward from swimming, feeling more mobile, and having less pain; swimming had become an integral part of the swimmer's lives.

'Because it helps, it's a self-fulfilling loop. And I like it and now I've done it enough I am starting to get the... I get out of bed, put clothes on, walk to the beach, my back is a bit grumpy, it doesn't move as well. Swim. Walking back is like you have gained an inch, is what it feels like. And you start to get endorphins, happy. So swimming is a weird one because it doesn't give you the instant hit that cycling really hard or running does, but I am beginning to realise that it does give you something so there is some little chemical reward going on as well.' (S1 outdoor swimmer)

5.28.3 Subtheme 3: Developing a setback plan and resilience

The swimmers all had a setback plan for when they experienced a flare up of symptoms; it was clear that some swimmers had always been resilient, and others had developed resilience since swimming.

'I used to spend a lot of time lying on my back to make sure that I wasn't straining it. But now what I am trying to do is stretch and things. I am trying to do stretches daily; but also, when it is painful. But generally, I haven't got a good effective method right now. Although I do know if I go swimming it will ease the pain.' (S11 pool swimmer)

The swimmers' setback plans usually involved easing off for a couple of days, being careful, sometimes taking painkillers, using ice and heat, and then starting to get moving again and stretching.

'I probably, I tend to kind of ease off most things for a couple of days to give it a rest completely and then swimming, and stretching are probably my first thing to go back to, I have tried to go back to a few classes and things like that. So, it is the stretching first and then back into water on smaller sessions.' (S14 pool swimmer)

It was clear from the language that hope was the dominant emotion for this group. However due to the interviews being carried out during the COVID-19 pandemic despair was also evident when the swimmers discussed the lockdown and restrictions on swimming.

'It is just about accepting it and moving forward and just always remembering what my osteopath said it doesn't define me and it these are just setbacks; it's not necessarily going to be as bad as it was when I couldn't walk. Yes, just keep looking forward really and keeping looking up; it could be a lot worse!' (S10 outdoor swimmer)

5.3 Discussion

This is the first study to explore the experience of swimmers who use swimming to manage CLBP. Experience is defined as *'the process of getting knowledge or skills from doing, seeing, or feeling things'* (Cambridge dictionary 2023) or the *'knowledge or skill in a particular activity which you have gained because you have done that activity for a long time'* (Collins dictionary 2023). The research approach undertaken has enabled the researcher to gain an insight into what it feels like to use swimming to manage CLBP and to understand the world as the swimmer experiences it. The five themes outlined a journey from the swimmers understanding and learning to self-manage CLBP, learning to swim with CLBP, adapting their swimming stroke, developing a training regime, integrating into a community of swimmers, and incorporating swimming into their daily life. The themes provide an insight into the strokes they used, their training regime, the barriers they faced, where they swam, their swimming community, and the therapeutic benefits they gained from swimming.

5.31 My Back Pain Journey

Most swimmers in this study had a long history of CLBP significantly impacting their life. The first theme provides context, giving the reader an understanding of the swimmers' background. For some specific injuries had triggered the condition, others couldn't recall an injury and their CLBP had developed over time. They had seen health professionals, been given a diagnosis, tried many different treatments, interventions and managements tools and were currently self-managing with several modalities including swimming. It is common for CLBP rehabilitation and self-management plans to include multiple modalities (Borys et al. 2015; Muller-Schwefe et al. 2017) this was evident in this theme whereby swimming was used alongside other modalities such as Yoga and Pilates. It was reassuring to hear that analgesic medication was only used during a setback as there are widespread concerns regarding dependency to opioids (Rosenblum et al. 2008) and the development of cardiovascular and gastrointestinal side effects from long-term use of nonsteroidal anti-inflammatory drugs (Kuritzky and Samraj 2012).

5.32 Learning to Swim with Back Pain

The swimmers all had a different journey learning to swim with CLBP. Despite swimming being a common recommendation by health professionals for CLBP, (Ribaud et al. 2013) people with CLBP are usually only provided with brief or vague guidance (CSP 2019; Versus Arthritis 2022). One ex-competitive swimmer started swimming after her physiotherapist had mentioned that swimming might be '*good for my back'*, some swimmers said that choosing swimming was an educated choice and others found it was helpful by chance. The study findings suggest that a simple recommendation to try swimming might be sufficient for a more able or ex-competitive swimmer, but less able swimmers may benefit from more support and guidance.

Swimming can be viewed in many contrasting ways; it can be used for play, competition and survival and can be a form of physical activity, exercise, or sport (Tsui 2020). Swimming on holiday might not be considered exercise but swimming 16 lengths after work could be and if the 16 lengths were swum at a gala, then swimming would be viewed as a sport. These different perspectives were evident in the interviews whereby some swimmers did not consider swimming a form of exercise whereas others were still competing. These findings are also supported by behavioral research conducted by Swim England which found that many people do not view swimming as a proper workout (Swim England 2017). Research has found that participation in sport as a child increases the probability of being physically active as an adult (Telama et al. 2006). Many of the swimmers in this study had been involved with other sports prior to starting swimming and some had chosen swimming as a transition from other exercise such as running. This finding suggests health professionals should inquire into previous experience in sport and exercise when recommending forms of exercise such as swimming, as those with no or little background may require additional support.

The swimmers discussed how the water provided support, stability, and a safe environment in which to exercise. They also described how their back felt whilst swimming, some sensations were deemed comfortable and others uncomfortable or painful. For the former words such as lengthen and stretch were used and for the later pressure, tighten, compression, pull, pivot, extend, flex and arch. The words they used create a picture and could provide insight into the swimmers' perception regarding the impact of swimming on their spine and CLBP. Although some swimmers spoke about discomfort, they followed this

by discussing how they adapted their stroke or choice of stroke to reduce or eliminate these sensations. Compared to other forms of exercise such as the walking or running, swimming takes place in an environment where there is much less visual and auditory sensory input and heightened kinesthesia (Kusanagi et al. 2017; Sato et al. 2020; Shaw 2006; Throsby 2013). In this study the support from the water alongside the heightened kinesthesia appeared to help the swimmers optimize their body position whilst swimming and adapt their stroke reducing discomfort whilst swimming. Further work exploring the use of kinesthesia when learning to swim with CLBP is required to further understand this effect and to help determine whether it is of therapeutic value when learning to swim with CLBP.

The four main swimming strokes are front crawl or freestyle, backstroke, breaststroke, and butterfly. Federation International De Natation (FINA) are the international federation for competitive water sports; they publish the rules for how the four swimming strokes should be swum in competition (FINA 2017-2021), and the rules are revised periodically following meetings. The description of the stroke is to allow fairness when swimmers compete, but the guidelines allow for a great deal of variation in the style of stroke swum. The findings from this small group of swimmers suggest that all four strokes could be considered, a better technique may be an advantage and barriers could be overcome through adapting the swimming stroke and taking lessons.

Front crawl was the most popular stroke for the swimmers and for most swimmers it was the most comfortable stroke for their back, most of the swimmers did not have to adapt front crawl. Front crawl is considered the most challenging stroke to learn (Liyanage 2020); breathing, body position, leg kick, posture, alignment, rotation and arm recovery, hand entry, catch and pull through all need to be considered when swimming front crawl (Newsome and Young 2012). Front crawl can be swum in many different ways, variations within the stroke include the breathing style, kick beats per stroke cycle, arm recovery, arm propulsion, body rotation and head position (Liyanage 2020; Newsome and Young 2012; Young 2016). It has been recognised that although front crawl involves very little spinal rotation or extension in elite swimmers in the general population many will use more rotation and extension due to deficits in technique (Dunlap 2009). This could be one reason why the less able swimmers reported that undertaking swimming lessons had a positive impact on both their swimming technique and back pain.

This group of swimmers reported swimming with their head above water was uncomfortable for their back, they were able to reduce discomfort when swimming with the head down by adjusting their head, body, and leg position. Some swimmers used drills alongside swimming the full stroke and some found that front crawl could gave them a sense of 'lengthening' through the spine and body. Swimming efficiently involves increasing propulsion whilst reducing drag (Wei, Mark, and Hutchison 2015); one swimmer spoke about utilising the drag by reducing her leg kick to enhance this feeling of '*lengthening*' though the spine. Research has found that during swimming different parts of the body will either create a net propulsive force or drag force, in the case of the swimmer who reduced her kick, this would have created more drag below her waist (Keys et al. 2015). There are other front crawl techniques which could also lengthen the body; for example, front-quadrant swimming, whereby one hand is always in the quadrant in front of the shoulder during the stroke cycle (Laughlin and Delves 2004).

Backstroke has been reported to be the most common stroke to recommend for LBP (Hofling et al. 2002), some of the swimmers in this study noted it was their most comfortable stroke. Biomechanical studies have found that the lumbar lordosis is less swimming backstroke than when compared to standing and swimming breaststroke (Hofling et al. 2002) and that swimming backstroke can be used to reduce hyper lordosis (Manshouri and Rahnama 2014). The position of the spine and the muscles recruited during backstroke could be one reason why this swimmers in this present study found backstroke more comfortable. Backstroke has been recommended for the management of spondylolysis and spondylolisthesis (Engelhardt et al. 1997), one swimmer had this condition and confirmed that backstroke was her preferred stroke. The swimmers described swimming both the modern and older versions of backstroke, and they reported alternating backstroke with other strokes. The less able swimmers lacked confidence swimming backstroke and found it challenging when swimming outdoors due to sighting issues; suggesting that they may benefit from lessons to develop technique and confidence.

Only one pool and one outdoor swimmer said that breaststroke was their preferred stroke and some swimmers mentioned that they had had been advised against swimming breaststroke; aligning with common guidance provided by health professionals (Dunlap 2009; Hofling et al 2002). This common recommendation may be based upon the assumption that

breaststroke increases the spinal lordosis (Hofling et al. 2003), however the scoping review in chapter two found limited biomechanical research to support this claim. One study included in the review found that stroke abnormalities either related to hyperextension in the spine or poor body balance could be a contributing factor to LBP (Coleman, Persyn and Winters 2000). There are three styles of breaststroke: the flat style, the wave style, and the undulating style (McCauley 1993). The wave style might increase the risk of LBP due to repeated hyperextension and flexion of the lumbar spine (Nyska et al. 2000), although the flat style is slower for competition, it might be better for swimmers with CLBP. There are also differences in the rate of turnover with breaststroke with the older style focusing on distance per stroke and the newer has a more rapid turnover (Anger 2018), and different kicks including the narrow whip kick and the wider wedge kick (STA 2021). Some swimmers reported discomfort such as a compression feeling in the low back or LBP when swimming breaststroke, but this did not result in them avoiding swimming this stroke. The swimmers discussed several strategies to enable them to incorporate breaststroke into their swim including alternating it with other strokes, not swimming the stroke during flare ups and warming up with other strokes beforehand. One swimmer found the symmetry of the breaststroke kick helpful for his back, some discussed taking lessons, and improving core strength. Swimmers with knee pain tended to avoid breaststroke, knee pain it is common in breaststroke swimmers (Capaci, Ozcaldiron and Durmaz 2002).

Butterfly is the most physically demanding of the four strokes to swim, few swimmers swam this stroke, it was only discussed by the long-term, ex-competitive swimmers. A survey of elite butterfly swimmers has found that 33.3% experience back pain (Capaci, Ozcaldiron and Durmaz 2002). It has been suggested that back pain during butterfly can be worse if the pelvis is in anterior tilt due to tight hip flexors (Pollard and Fernandez 2004). The '*arch*' during butterfly was mentioned by one of the swimmers as problematic and others said that their back didn't have sufficient flexibility to swim the stroke. The more able swimmers reported that they would consider the full stroke or butterfly legs on their back, they found it was good practice to warm up with other strokes before swimming butterfly and they would avoid swimming this stroke if they were experiencing a flare up.

When swimming there is the option to swim just one stroke or to alternate different strokes; the more able swimmers reported that alternating strokes was helpful for managing

discomfort during the swim, it was good for balance, and helped alleviate boredom. Some people with CLBP find that being in one position can cause more pain and stiffness but other people find they have less back pain when in one position (Tonosu et al. 2016). Comorbidities such as knee and shoulder pain can also impact swimming and choice of stroke. Both knee and shoulder pain were mentioned during the interviews; it has been reported in other studies that breaststroke can be problematic for knees (Vizsolyi et al. 1987; Wanivenhaus et al. 2012) and that shoulder problems are the most common complaint among swimmers (Sein et al. 2010; Wanivenhaus et al. 2012). Three swimmers discussed nerve damage which can occur in people with a back condition if a disc prolapse compresses a nerve, resulting in weakness, numbness, and persistent pain (Lui et al. 2013). The swimmers reported being able to adapt their swimming to accommodate for this weakness.

Some swimmers had been taught to swim to a high level as a child whereas others had learned basic swimming skills but were not able to swim all strokes to a high standard. The ex-competitive and more able swimmers appeared to have more strategies when adjusting strokes and a greater choice of strokes and drills to practice. They could problem-solve and adapt their swimming technique; a process which has been found beneficial when learning to swim and developing swimming technique (Light and Wallian 2008; STA 2018; Swim England, 2019b). The less able swimmers were taking lessons to develop technique and confidence in the water, they found this experience helpful both for their swimming and CLBP. The findings from this theme support the need for the development of specific swimming guidance for people with CLBP and lessons and coaching sessions which take a problem-solving approach.

5.33 How Swimming Looks for me

The swimmers considered the benefits and drawbacks of swimming in a pool and outdoors. The outdoor swimmers discussed how there was no cost to swim outdoors, they were able to swim when they wanted, there was more space, they found it more refreshing, less boring, and more enjoyable. They also found that the colder water had additional benefits for pain and mood. However, when swimming outdoors they spent less time in the water due to the cold and they had to be aware of the weather and sea conditions. There are additional

variables to consider when comparing pool swimming with outdoor swimming, such as exposure to cold water, being outside, and the phenomenon known as blue health which may offer additional therapeutic value (Kelly, 2021; Nichols, 2014). When undertaking research in the field of swimming it is important to consider whether the therapeutic benefits described by the outdoor swimmers were due to the action of swimming or due to the location or the temperature of the water. These questions are being considered researchers in the field of outdoor swimming (Massey et al. 2020).

The pool swimmers preferred swimming indoors, some swimmers felt their back was worse in colder water and one of the outdoor swimmers noted that the pool was a better place for learning new skills. One outdoor swimmer felt that the pool was an intimidating place due to the faster swimmers and she had a sore throat after swimming in a pool due to the chlorine; chlorine has been found to contribute to airway irritation in competitive swimmers (Swinarew et al. 2020). Unlike swimming outdoors in a pool there are rules that must be followed, enforced by lifeguards and lane etiquette to consider (Scott 2009). This system of lanes for swimmers of different abilities enables swimmers to flow in an orderly fashion (Scott 2009) but also creates a tiered system where the less able swimmers could feel intimidated. Swim England have been trying to make swimming more accessible following their behaviour change research with the development of their three frontiers mode, this includes improving the visibility and relevance pool swimming (Swim England 2017).

Some swimmers swam with clubs or informal groups; these groups provided valuable support to the swimmers. For the outdoor swimmers the groups were important for social reasons but also for safety; due to the greater risks associated with swimming outdoors (Deacon and Allan 2019; Tipton et al. 2017). The outdoor swimmers were concerned that their fellow swimmers were safe during and after their swim, and that experience may have brought the group closer together, this has also been found in other studies involving outdoor swimmer (Denton and Aranda 2020). One outdoor swimmer spoke about a charity she volunteered for called mental health swims. It allowed people to meet up with other outdoor swimmers helping make the swim safer and providing social support (Mental Health Swims 2021). The pool swimmers did not discuss this experience, presumably because it was the lifeguard's responsibility to keep the swimmers safe. The outdoor swimmers discussed inclusivity and swimming; one swimmer spoke about the process that she took to '*enter that world*' and

become a swimmer as she had not been involved in sport as a child. Health and exercise professionals need to be aware of this issue and facilitate the transition, such as allowing people to observe a session, to see what people wear and how things work.

The swimmers discussed their training regime, including warmups, building up gradually, knowing when to taper and tracking progress. Training can be defined as *'the pursuit of activity that will ultimately lead to an increase in performance in a given sport'* (Bahr 2007). Training as a skill is useful for any swimmer but for people with CLBP it could help get the 'dose' of swimming right and reduce the risk of flare ups. Training methods used included aerobic training, anaerobic training (ex-competitive / current competitive swimmers only), specific skill and technique training, flexibility training, core strength exercises and cross training. The range of training techniques utilised by the swimmers in this study has been rarely reported in other trials involving exercise CLBP (Hayden et al. 2021). This might be because swimming unlike other forms of exercise recommended for CLBP can also be considered a sport. The UK government advise adults to do 150 minutes of moderate physical activity each week (Department of Health and Social Care 2020); the swimmers in the study were close to or achieving this target; this level of physical activity is likely to benefit their physical and mental health.

Only the ex-competitive swimmers completed a land-based warm up prior to swimming, the swimmers who didn't reflected that maybe they should, others did not have the time, or they lacked confidence. The swimmers would swim at a slower pace with a certain stroke or stroke combination when warming up in the water. Warmups and land-based conditioning programs are often recommended to swimmers to reduce the risk of injuries and improve performance (Austin and Noble 1994; Newsome and Young 2012; Swim England 2021) and research with elite swimmers has found that a program of strengthening and mobility exercises can reduce the rate of lumbar injuries (Matsuura et al. 2019). Given that people with CLBP might have loss of movement and deficits in muscle strength a dryland warm up or a dryland conditioning program could be of benefit.

5.34 What I Gain from Swimming

A wide range of therapeutic benefits were discussed by the swimmers, including relief from symptoms, improvement in physical and mental health, and function. Relief can be defined as the *'feeling of happiness that you have when something unpleasant stops'* (Oxford dictionary, 2023). This word was used to described relief from pain, stiffness, and compression through the spine. Using the word relief could suggest that the improvement gained through swimming was linked with the emotion of happiness and this could have a positive impact on mental health, wellbeing, and automatic motivation (Banting, Dimmock and Grove 2011). It has been found there is a positive relationship between negative emotions and increased pain and disability (Edwards et al. 2016). The words the swimmers used during the interviews conveyed positive feelings such confidence, enthusiasm, hope, and empowerment, which reflected their current levels pain and function. The swimmers spoke about the wider benefits of swimming for example how swimming had helped them lose weight and maintain a healthy weight. Research exploring the role of swimming in weight management has had mixed results, some studies have found that swimming has a positive impact (Cox et al. 2010; Walsh et al. 2013) whereas other studies show no impact on weight management (Gwinup 1987; Tankaka et al. 1997). Some swimmers discussed how they had found swimming beneficial for their mental health. Other surveys and research in the field of swimming has have found that blue spaces and swimming can reduce in tension, depression, and anxiety (Berger and Owen 1987; Berger and Owen 1992; Better 2023) and masters swimmers are significantly less likely to take medication for mental health (Potdevin et al. 2015). A recent survey found that 64.9% of outdoors swimmers reported that outdoor swimming is essential or very important for their mental health (Outdoor Swimmer, 2021), other studies have also reported that outdoor swimming is used by swimmers for their mental health and wellbeing (Denton and Aranda 2020; Foley 2015). Similar physical and psychological benefits were found in another qualitative studies involving water-based exercise for people with chronic pain (Larmer, Kersten and Dangan 2014).

5.35 Keep Calm and Carry-on Swimming

Motivation and resilience was a common theme in this group of swimmers, CLBP can be a long-term condition, so these attributes could be beneficial. Many theories have been developed to help explain and understand motivation, including the self-determination theory (Cook and Artino 2016). The self-determination theory describes the transition from amotivation, through the different forms of extrinsic motivation to intrinsic motivation, which is considered the healthiest form of motivation (Cook and Artino 2016). None of the swimmers were amotivated, but this is unsurprising due to the eligibility criteria for this study. Their goals and reasons for swimming were part of their identity, suggesting that they could be placed in the integrated regulation phase of being extrinsically motivated. Goals included wanting to swim faster, signing up for events and challenges, these are behaviour change techniques which can help improve motivation (Dekker et al. 2020). The swimmers shared personal reasons why they keep swimming, including wanting to maintain a healthy weight, feel more mobile, have less pain, improve fitness, improve wellbeing and keeping more mobile in the future. One of the outdoor swimmers spoke about group motivation also being important source of motivation. Some swimmers spoke about the enjoyment they gained from swimming; suggesting that many were intrinsically motivated. The COM-B model includes both automatic and reflective motivation (Michie, Atkins and West 2014); the findings from this study suggest that the swimmers were drawing both types of motivation.

The swimmers swam regularly and had developed an exercise habit; going swimming had become automatic and an integral part of the swimmer's lives. Habit formation is linked with behaviour change, impacting adherence to exercise, and can be divided into preparatory and performance phases (Kaushal et al. 2018). The preparatory phase has been found to be a strong predictor of developing an exercise habit (Kaushal et al. 2017) and this phase was discussed during the interviews, for example one swimmer described the process of getting up, getting dressed and walking to the beach before her swim. It has been suggested that four factors are influential when forming a habit: reward, consistency, cues, and low behavioural complexity (Gardner and Lally 2013). The swimmers spoke about the '*chemical reward*' from swimming, feeling more mobile, and having less pain.

The swimmers all had a setback plan for when they experienced a flare up of symptoms; it was clear that some swimmers had always been resilient, and others had developed resilience since swimming. Resilience has many definitions but has been defined as *'a dynamic process encompassing positive adaptation with the context of significant adversity'* (Luthar, Cicchetti and Becker 2007, p.1) or the *'ability to bounce back'* (Smith et al. 2008, p.194). CLBP is a recurrent condition that fluctuates in intensity and symptoms (Young et al. 2011) so resilience would seem to be a desirable attribute. Mindfulness and CBT techniques have been found to improve resilience (Joyce et al. 2018), swimming offers people a chance to practice mindfulness, to be in the present moment whilst exercising (Denton and Aranda 2020; Foley 2015; Tsui 2020). It has been suggested that swimming outdoors could improve resilience (Denton and Aranda 2020), however it is not known whether swimming improves resilience. The swimmers all had a clear setback plan, they knew how they would cope when their pain and symptoms increased. The fluctuating pattern of CLBP can result in the contrasting emotions of hope and despair (Corbett, Foster, and Ong 2007); it was clear from the language that hope was the dominant emotion for this group.

5.36 COM-B Model

Subthemes were mapped onto the COM-B model in order to understand how they could impact the behaviour of swimming; it was found that the subthemes developed during this study covered all components within the COM-B model (Michie, Atkins and West 2014). Physical and psychological capability could relate to the swimmers having the necessary swimming and pain management skills and knowledge to be able to use swimming as a self-management tool. Theme 1, *my back pain journey*, theme 2, *learning to swim with back pain*, theme 3, *how swimming looks for me*, subtheme, *my training regime*, and theme 5 *keep calm and carry-on swimming*, subtheme, *developing a setback plan and resilience*, aligned with the physical and psychological capability components on the COM-B model. This finding supports the need for additional support for people with CLBP when recommending swimming, engagement with swimming stakeholders and the provision of a swimming programme to enable the teaching of these swimming and pain management skills.

Physical opportunity refers to opportunities related to the environment, the pool or outdoor swimming location, time, money, and other resources such as swimwear and social

opportunity refers to interpersonal influences, such as access to a swimming community and the inclusiveness of this community. Theme 2, *learning to swim with back pain*, subtheme, *my swimming journey*, and theme 3, *how swimming looks for me*, subthemes, *where I swim*, *my swimming community* and *my training regime* aligned with the physical and social opportunity components on the COM-B model. The findings support the need for support for people with CLBP through the development of inclusive swimming communities, accessible swimming locations, guidance on the use of swimming and training regimes, and the recognition of barriers.

Reflective motivation refers to reflective processes including being able to schedule swimming and beliefs about the value of swimming and automatic motivation refers to automatic processes related to engagement in swimming, including emotional reactions, therapeutic benefits, or unwanted side effects from swimming. Theme 4, *what I gain from swimming*, subthemes, *relief through swimming*, *swimming improves my physical and mental health and helps me function* and *my feelings about swimming* and theme 5, *keep calm and carry-on swimming*, subthemes *my goals and motivation* and *developing a swimming habit* aligned with the reflective and automatic motivation components on the COM-B model. The findings support the need for health professionals to highlight the potential therapeutic benefits and side effects from swimming and enabling the exploration of personal swimming goals, motivation, and the development of a setback plan for flare ups. This COM-B analysis illustrates that a simple recommendation may not translate to someone with CLBP taking up swimming due to the complex inter-related behaviours impacting uptake and engagement. It is recommended that health professionals consider all components of the COM-B model and engage or signpost to other stakeholders such as swimming professionals when recommending swimming. Figure 19 provides an overview of the themes and subthemes mapped onto the COM-B model.

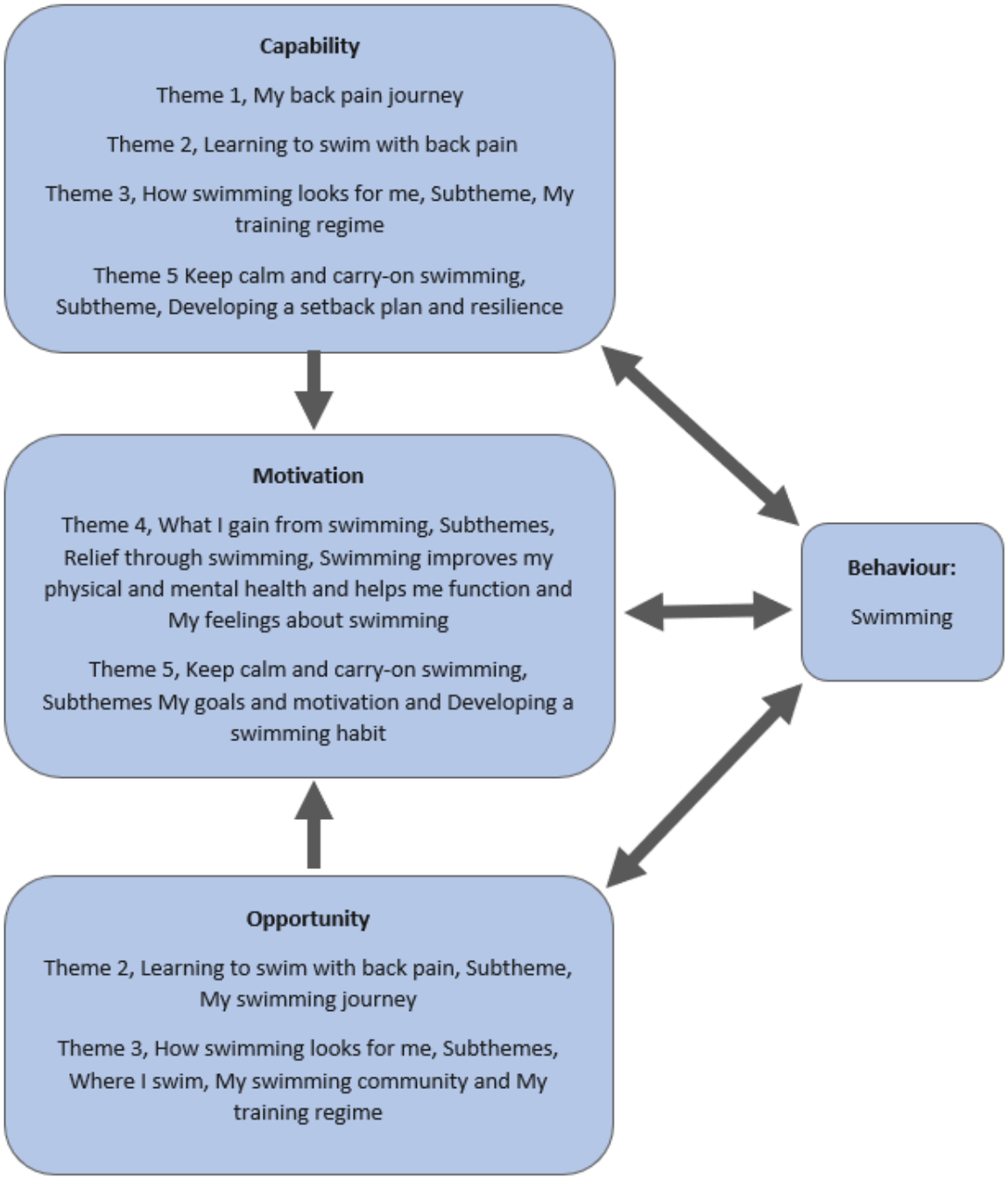

Figure 19: Themes and Subthemes mapped onto COM-B model

5.37 Reflexivity

Reflexivity has been defined as *'the practice in which researchers strive to make their influence on the research explicit to themselves and the audience'* (Gentles et al. 2014). It has been recommended that personal, interpersonal, methodological, and contextual dimensions should be considered when writing a reflexivity statement (Olmos-Vega et al. 2023). In the case of this study reflexivity has been considered in terms of the impact on the study conduct and findings and whether factors strengthened or posed a limitation to the study.

5.37.1 Personal

The researcher is an advanced practice physiotherapist specialising in spines, her work in a secondary care NHS trust involves assessing people with chronic spinal conditions, requesting investigations, and advising conservative management including exercise. In her spare time, she swims with a masters swimming club, competing in both pool and outdoor events; she is a level 2 swimming coach and over the last 10 years she has volunteered at her local club. She is not currently suffering with CLBP but has suffered with short episodes of LBP. This background and expertise allowed the researcher to understand the language of swimming and CLBP, enabling conversation to flow, without the need for clarification. Her competitive background in swimming and the experience of working as a physiotherapist could have led the researcher to focus more on the technical aspects of swimming. However, her training and approach as a physiotherapist and well-developed listening skills enabled the researcher to appreciate all aspects of the swimming experience, not just the physical. Not suffering from CLBP was an advantage in this study as she was open to all experiences and was not drawing upon her own experience.

5.37.2 Interpersonal

The study was advertised via social media; the swimmers contacted the researcher and chose the location of the interview to reduce the power imbalance. The swimmers were aware of the researcher's background as a physiotherapist, swimmer, and PhD candidate, this was stated on the information sheet and discussed at the start of the interview. The study was distinctive in that it recruited people who were already self-managing CLBP; many CLBP studies recruit people seeking care. The swimmers in this study were not just experts in the

management of CLBP but also experts in the use of swimming; they had a wide range of swimming backgrounds and were swimming in different locations; both indoors and outdoors. This breadth of expertise and experience was of great value and was recognised by the researcher as an asset. It was acknowledged that it was impossible to reduce power imbalance entirely but the study procedures and the expertise of the people in the study meant that the imbalance was minimised.

5.37.3 Methodological

The study was conducted within the paradigm of pragmatism, forming part of a mixed methods study which aimed to develop a swimming programme for people with CLBP. It was acknowledged that other research paradigms could have yielded different findings. Conducting research within this paradigm enabled the researcher to collect data by '*what works'*, recognising that in the world of personal experience, there are many interwoven, confusing, and unclear experiences. For the purpose of this study although all personal experiences were recognised, the ones which have guided the project and the development of the swimming programme were the focus of the study. Practical significance in the analysis is recommended in this paradigm, in practice this was through the use of a priori codes to ensure that certain aspects of the experience were included alongside the use of in vivo codes which enabled other themes to be developed.

5.37.4 Contextual

The study was conducted during the COVID-19 pandemic during September and October 2020; this was a period when the pools were open and outdoor swimming was permitted. This meant that most people had swum during that week and were able to easily able to discuss their experience of swimming. Initially the study had been designed to be undertaken in the hydrotherapy pool, in order that there could be a practical element to the interview, however the hydrotherapy pools were closed during the study period (CSP 2022) and the protocol was amended. Most of the leisure centre pools had reopened (GOV.UK 2020) but it was not possible to conduct the interviews in this location due to issues with cost and confidentiality. The interviews were conducted via telephone, video, or in person outdoors. The location of an interview can shape the data collected and the discussion during the

interview can be dependent on the context of the interview. Interviewing in a pool environment could have allowed for richer collection of data as the swimmers may have recalled more information relating to swimming if they were sat next to a pool and were in a pool than if they were at home. It would have also allowed for demonstration of swimming technique which may have provided further insight.

5.38 Information Power

An appraisal of the sample size in qualitative interview studies can be undertaken using the information power model which considers five dimensions: the study aim, the specificity of the sample, the use of theory, the dialogue quality and the analysis strategy (Malterud, Siersma and Guassora 2016). The model allows researchers to assess whether sufficient information power is gained with a proposed sample size, see Figure 20.

⟸ Higher information power				
Narrow	⟸	Aim	⟹	Broad
Dense	⟸	Specificity	⟹	Sparse
Applied	⟸	Theory	⟹	None
Strong	⟸	Dialogue	⟹	Weak
Case	⟸	Analysis	⟹	Cross-case
			Larger sample size (N) ⟹	

Figure 20: Information power model: Items and dimensions (Malterud, Siersma and Guassora 2016)

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In the case of this present study the aim was to explore the experience of swimmers who use swimming to manage CLBP. Swimming takes many forms suggesting that the study aim was broad, however it could also be reasoned that as the focus was using swimming to manage CLBP, the study aim was narrow. With reference to sample specificity the participants all had CLBP, and it is known that CLBP is a complex condition impacting people in many ways, suggesting the sample specificity was sparse. Due to the recruitment strategy the participants in this study were not seeking care but were managing independently in the community suggesting that the sample would be moderately specific. The study had been designed based

upon the COM-B and BCW analysis, due to the recognition that uptake and engagement in swimming requires behaviour change. The COM-B model was used as a theoretical lens to analyse the data, enabling the behavioural dimensions of swimming and CLBP to be understood, this application of theory increased the information power in this study. The reflexivity statement highlighted that the researcher had expertise in working with people with CLBP, understanding swimming and conducting interviews, suggesting that the quality of dialogue in the interviews would be strong, again increasing the information power. The analysis strategy was cross-case; therefore, a very small sample size would not provide sufficient information power for this type of analysis, again pointing towards the need to recruit a moderate number of people. It is recognised that this appraisal of information power does not replace data saturation models but can be used alongside the models to improve the transparency and internal validity of the study.

5.39 Strengths and Limitations

This is the first study to use research methods to explore the experience of swimmers who use swimming to manage CLBP. The introduction chapter had highlighted that there is limited data on the uptake and use of swimming in this population and the only accounts have been individual case studies published by Swim England and in swimming biographies and books. Although these stories are of interest, they have limited value as they are single person case studies. This study has used research methods to evaluate and synthesise the experiences of swimmers with CLBP to identify whether there are common themes in these stories and experiences. Although the original analysis was conducted by the researcher, to improve the credibility of the data the codes, subthemes and themes were checked also by the supervisory team, some were changed or adapted for the final version.

It was recognised that there were several limitations to this study, some limitations such as the time period during which the study was conducted, and the lack of a practical component has already been discussed in the reflexivity section. It was also recognised that recruiting a population of '*expert patients'* may have led to a one-sided view on the experience of using swimming to manage CLBP. People with CLBP who had not found swimming to be a helpful tool for the management of CLBP could have also been recruited. This has identified this as

an area for future research, as it could enable a better understanding of the barriers to the use of swimming in this population, inform future development of a swimming programme and the advice provided to people with CLBP.

5.4 Conclusions and Recommendations

The aim of this study was to explore the experience of swimmers who use swimming to manage CLBP. The swimmers in this study found swimming to be a valuable and effective self-management tool for CLBP. The five themes outline a journey from the swimmers understanding and learning to self-manage CLBP, learning to swim with CLBP, adapting their swimming stroke, developing a training regime, integrating into a community of swimmers, and incorporating swimming into their daily life. The themes provide an insight into the strokes they used, their training regime, the barriers they faced, where they swam, their swimming community, and the therapeutic benefits they gained from swimming. The research approach undertaken has enabled the researcher to gain an insight into what it feels like to use swimming to manage CLBP and to understand the world as the swimmer experiences it.

The study findings suggest the current adult Swim England and STA adult learn-to-swim frameworks might not meet all the needs of people with CLBP. Although these swimming frameworks provide specific learning outcomes to guide the structure of a swimming session, enabling adults to develop swimming skills; the frameworks do not provide guidance on adapting swimming and developing a training regime to manage long-term conditions such as CLBP. Furthermore, the frameworks do not consider barriers to swimming, how to integrate swimming into daily life, and how to access an inclusive swimming community. The findings from this study suggest that these factors could be important components when learning to swimming with CLBP. Although it is recognised that the results from qualitative research studies cannot be generalised, the study findings could guide other research in the field and current clinical practise. For example, the themes developed during this study could provide a guide for health professionals to facilitate a more comprehensive discussion when recommending swimming to people with CLBP.

As a standalone study the findings highlight that vague or brief guidance when advising swimming to people with CLBP may not translate into the person becoming a swimmer, the themes and subthemes support the suggestion that recommending swimming is not a simple intervention for many people. The findings support the teaching of swimming and pain management skills to people with CLBP, the provision of specific guidance on the use of

swimming and training regimes, the development of inclusive swimming communities, and accessible swimming locations. The findings also suggest that when advising swimming health professionals should spend time discussing barriers to swimming and explore personal swimming goals and motivation, they should highlight the potential therapeutic benefits and side effects from swimming and enable the development of a setback plan for flare ups. Evidently, if swimming is to be adopted as a self-management tool, people with CLBP will need to develop the skills, knowledge, motivation, confidence, and resilience, and have access to facilities and inclusive swimming communities. The findings support the need for multi-professional support and the development of a swimming programme for this population addressing all COM-B model components.

Chapter 6

Study Three: Development of a Swimming Programme as a Rehabilitation Modality for People with Chronic Low Back Pain

6.0 Introduction

Swimming is often advised by health professionals to people with CLBP as a form of exercise despite limited research and low levels of swimming ability in a proportion of the adult population (Pocovi et al. 2022; Ribaud et al. 2013; Swim England 2019a). Unlike other forms of exercise recommended for CLBP, such as walking or cycling, swimming is a more complex skill to learn and master (Laughlin and Delves 2004). There is also evidence to suggest that swimming stroke defects, causing a secondary effect on the body could impact the movement and position of the spine during swimming, supporting the development of a more proficient swimming technique in this population (Cole et al. 1997). There are several adult learn-to-swim frameworks, the most common ones used in England were developed by Swim England and the STA following consultation with swimming professionals and experts in the industry (STA 2023; Swim England 2023a). These frameworks consist of progressive stages, enabling swimmers to develop water confidence, aquatic skills, swimming strokes, and technique (STA 2023; Swim England 2023a). There are also numerous manuals which aim to teach adults to swim and develop swimming technique (Laughlin and Delves 2004; Liyanage 2020, Newsome and Young 2012; Shaw 2006; Smith 2014; Young 2016). Despite the widespread use, the learn-to-swim frameworks and manuals have not been evaluated using research methods. To date swimming research has focused on water safety (Stallman, Junge and Blixt 2008), improving performance in competition (Riewald and Rodeo 2015) and exploring the benefits of swimming for general health (Lahart and Metsios 2018). It is recognised that the experts who have developed these frameworks and manuals have a wide range of swimming backgrounds, ranging from competitive swimmers and triathletes (Laughlin and Delves 2004; Newsome and Young 2012) to swimming teachers with a non-competitive background (Liyanage 2020); these experiences and world views will impact on the approach they recommend. It is not known which learn-to-swim frameworks and methods are most effective and efficient at teaching and coaching swimming and whether some methods are better for certain

populations, such as people with CLBP. Furthermore, there are no published frameworks or guidelines for using swimming as a rehabilitation modality. A consensus method such as the Delphi technique or the nominal group technique is sometimes used where there is limited research (Jones and Hunter 1995); the Delphi technique is more commonly used to develop guidelines (McMillan, King, and Tully 2016). When developing a swimming programme for people with CLBP it was recognised that to gain a holistic perspective and improve the acceptability and usability of the intervention that all stakeholders should be involved, including swimming teachers and coaches, physiotherapists, and people with CLBP.

The aim of the study was to use a modified Delphi technique to develop a swimming programme as a rehabilitation modality for people with CLBP, consulting swimming professionals, physiotherapists, and people with CLBP.

6.01 Research Question

What is the consensus among stakeholders on how a swimming programme could be delivered as a rehabilitation modality to people with CLBP?

6.02 Study Objectives

To develop a swimming programme as a rehabilitation modality consulting swimming professionals, physiotherapists, and people with CLBP, using a modified version of the Delphi technique to gain a consensus on the following aspects of a swimming programme:

1. Programme set up: time in water, frequency of sessions, number in session and time of day
2. Pre-programme information: general health, back pain and swimming ability and experience
3. Delivery of programme
4. Teaching and coaching approaches
5. Content of session brief and debrief, warmup, and cool down
6. Teaching the core aquatic skills
7. Teaching the swimming strokes, including strokes which could be helpful, stroke variability and adaptations, and strokes to avoid
8. Strategies to enable people with CLBP to become regular swimmers on completion of the programme

6.1 Methods

6.11 Study Design

Three-round modified Delphi study

6.12 Participants

Three distinct groups of participants were recruited via a social media advert and through posters displayed in a physiotherapy waiting room:

1. Experienced musculoskeletal physiotherapists, qualified for more than 5 years, with a special interest in CLBP.
2. Experienced swimming teachers or swimming coaches, qualified for more than 5 years, with experience teaching or coaching adults to swim.
3. People experiencing CLBP for more than 3 months, aged at least 18 years old with an interest in swimming.

Participants were excluded from this study if they were unable to read and speak English. The aim was to recruit a minimum of 15 participants, five in each group.

6.13 Study Procedures

The first-round questionnaire asked open ended questions about the content and the delivery of a swimming programme which could be delivered as a rehabilitation modality for people with CLBP; the purpose of this round was to generate ideas. The questionnaire was based upon the Swim England STA lesson plans (STA 2018; Swim England 2019b) and the ATACP guidelines when delivering aquatic therapy (ATACP 2021). The initial objectives of the swimming programme were shared with the participants in order that they could understand the purpose of the swimming programme, see Table 2, pp.49-50.

In round two the participants were asked using a Likert scale, whether they strongly agree, agree, disagree, strongly disagree or were unsure with the proposed content and delivery of the swimming programme. There was also the option to provide comments for each question. In the third round the questionnaire was revised for any area in which there was less than 70%

consensus. The participants were again asked using a Likert scale whether they agreed with the proposed content and delivery of the swimming programme. A thank you voucher was sent to participants on completion of the last questionnaire, see Appendix D, E and F for copies of the three questionnaires.

6.14 Data Analysis

6.14.1 Process

The Delphi technique is a mixed methods approach, combining both qualitative (QUAL) and quantitative (QUAN) methodologies, the technique usually follows the following format:

QUAL -> QUAN -> QUAN

This study took a modified approach, integrating data from study one and two:

(QUAN + QUAL + QUAL) -> QUAN -> QUAN

6.14.2 Qualitative analysis after round one

The open responses data from round one, were analysed using thematic analysis, using a combination of a priori and in vivo coding; the coding aligned with the aims and objectives of the study. The a priori coding was based upon the STA and Swim England lesson plans (STA 2018; Swim England 2019b) and usual clinical practice when delivering aquatic therapy (ATACP 2021). Whilst reading the survey responses the researcher also developed in vivo codes for areas outside these current frameworks and guidelines.

6.14.3 Combining the data from study one, study two and the round one survey to develop the round two survey

The integration of findings from the three studies was based on the process described by Skamagki et al. (2022), Gutterman, Creswell and Fetters (2015) and Fetters, Curry, and Creswell (2013). The authors recommend using joint display tables which enable organisation and analysis of mixed methods datasets. In the case of this Delphi study there were eleven joint display tables which covered the different sections of the proposed swimming programme, see Appendix G. The purpose of the meta inference and interpretations was to consider the data from study one, study two and round one of study three in order to develop

the round two survey for study three. The first column documents the data from the thematic analysis, including the codes with examples of quotes from the round one survey. The second column contains relevant quantitative data from study one and the third column relevant qualitative data from study two. The fourth column of the table shows the meta inferences and interpretations, which include the following options: convergence, divergence, and complimentary. For the set-up programme section, the time in water and frequency data from the scoping review was also considered. Convergence refers to a positive relationship between the data whereas the term divergence is used when there is a lack of agreement; complimentary is used when new insights are discovered during the mixing of data (Skamagki et al. 2022). The final column shows the proposed plan for the round two survey in study three and the COM-B and BCW analysis for this proposed plan. The purpose of including the COM-B and BCW analysis was to understand how the sections of the programme could impact on the behaviour of swimming and to review interventions to target these components.

6.14.4 Quantitative analysis after round two and three

The closed responses from rounds two and three were analysed and presented as the mean, percentage agreement and standard deviation (SD). The benchmark set for this study was that there should be at least 70% agreement and that the SD should not be greater than 1.0; aligning with benchmarks set in other Delphi studies (Slade et al. 2014; Veugelers et al. 2020; Vogel et al. 2019). SD is a measure of consensus, illustrating the level of variability in the answers (Field 2009). Responses were ranked by calculating the mean; the higher the mean the stronger the level of agreement in the group, see Figure 21 for data analysis flow chart. The median and interquartile range (IQR) could have been chosen as measures of central tendency but as the data was feedback to the participants who may not be familiar with statistics it was decided that the mean and standard deviation would be easier to understand (Field 2009). The data analysis process was shared with the participants after each survey round, as recommended with this research method. The sections of the swimming programme were mapped onto the COM-B model and BCW wheel using the process described by Michie, Atkins, and West (2014).

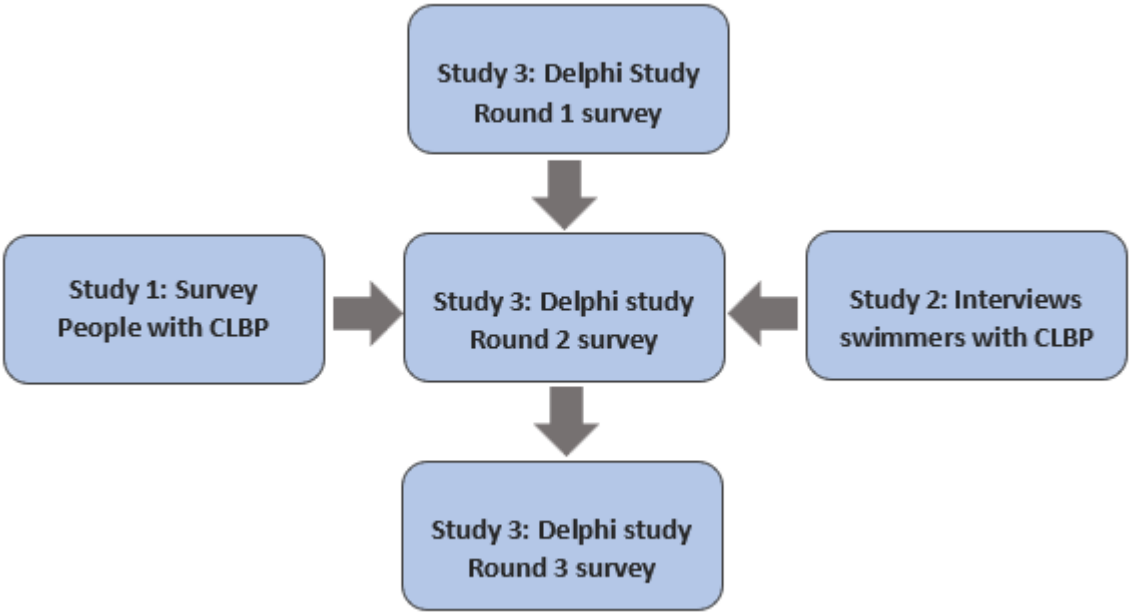

Figure 21: Data analysis flow chart

6.2 Results

17 participants were recruited for the study with 17 completing round one, 15 completing round two and 14 completing round three. The group comprised of five people with CLBP, six swimming teachers / coaches and six physiotherapists.

The results are presented under the eight study objectives. The tables for the results from the round two and three surveys are presented in the main results section. The tables include the proposed plan shared in round two, and the data analysis from round two and round three, including the mean, percentage agreement and standard deviation (SD). Sections highlighted in dark grey were not included in the final programme due to there being less than 70% consensus amongst participants or greater than 1.0 SD that could not be resolved in round three. The joint display tables detailing the analysis after the round one survey can be found in Appendix G.

6.21 Consensus on Programme Set Up

6.21.1 Time in water

Two a priori codes were used to analyse the data from the round one survey to guide the length of the session: '*time in water'* and '*considerations.*' The participants suggested that the length of the session should be based on the individual; estimates ranged from 15 minutes to 60 minutes, 30 minutes was the average time suggested. Factors to be considered included the condition, pain severity, mobility, swimming ability, age, water temperature, length of time to warm up and current activity level. They recommended starting with less time and building up; based upon an individual's response to swimming, their confidence and strength. When the data was integrated from study two the data was congruent based upon the theme, *how swimming looks for me*. The theme suggested that there were many personal and external factors which could impact the length of the session. The interventional studies from the scoping review were also considered; the time in water ranged between 30 and 90 minutes. Two programmes cited the time for a programme which combined exercise and swimming; 90 minutes (Ariyoshi et al. 1999) and 40 minutes (Winter and McCauley-Callagy 2002), and the other two quoted the time spent swimming; 40 minutes (Kim, Kim, and Jung 2008) and 30 minutes (Weifen et al. 2013). Based upon the integration of data the proposed average time for the session in round two was 30 minutes.

6.21.2 Frequency of sessions

Two a priori codes were used to analyse the data from the round one survey to guide the frequency of the session: '*frequency of sessions'* and '*considerations.*' The participants suggested that the frequency of the sessions should depend on the individual; estimates varied from between one to four times a week, twice a week was the average frequency. Points raised included the importance of having a few days break between sessions, levels of pain and finances could impact the frequency of the sessions and longer gaps could impact learning. When the data was integrated from study one and two the data was congruent based upon the barriers data and the theme, *how swimming looks for me*. The barriers data had found that 47.5% of people would find it difficult to find the time to go swimming and the theme, *how swimming looks for me,* suggested that there were many personal and external factors impacting swimming frequency. The interventional studies from the scoping review were also considered; the frequency of the sessions ranged between once and five times a week; it was noted that the one reporting five times a week had recruited retired athletes (Ariyoshi et al. 1999; Kim, Kim, and Jung 2008; Weifen et al. 2013; Winter and McCauley-Callagy 2002). Based upon the integration of data the proposed frequency for the sessions would be once to twice a week.

6.21.3 Number in session

Two a priori codes were used to analyse the data from the round one survey to guide the number in the session: '*number in session'* and '*considerations*.' There were several considerations, including the number of teachers and lifeguards, condition, body confidence and swimming ability. Estimates ranged from between one and twelve swimmers, the average response for the size of the class was five. It was noted that larger groups could have additional benefits such as more social interaction, support, and peer learning. There was no data from study one and two for meta inference. Based upon the suggestions from the round one survey the proposed programme would be offered to a group of five people.

6.21.4 Time of Day

Two a priori codes were used to analyse the data from the round one survey to guide the time of the session: '*time of day'* and *'considerations*.' There were a wide range of responses to this question. The people with CLBP reported that it took time to get moving in the morning; late morning or early afternoon would be best, they recognized that offering a time outside

normal working hours and a range of times would improve access. Other suggestions included offering sessions at a time when a person might struggle to improve mobility and provide relief. When the data was integrated from study one and two new insights were observed based upon the preference data from study one and the data was congruent with the theme, *how swimming looks for me*. The preference data had identified that 34% of participants would prefer to swim between 9-12pm and 21.1% between 5-7pm. The theme, *how swimming looks for me,* suggested that there were many personal and external factors impacting the time of the session. Based upon the integration of the data the proposed programme would be offered at different times during the day, except for early morning and late evening.

The round two survey proposed the following programme set up; see Table 24.

Table 24: Round two and three data for set up of programme

Programme set up	**Round two**			**Round three**		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Frequency of sessions 1-2 week	1(1.73)	100	0.46	No		
Length of session 30 mins	2(1.80)	93.33	0.56	No		
Group size 5	3(2.26)	73.33	0.80	No		
Time of Day	4(2.40)	66.67*	1.12**	No		

*less than 70% agreement; **greater than 1.0 SD

In round 2 there was at least 70% agreement that the average length of session would be 30 minutes, the sessions could be offered between once or twice a week and the average number in the group could be five. There was less than 70% agreement on the time of day that the session could be offered, therefore it was proposed that a range of times would be offered. When mapped onto the COM-B model the programme set up would need to consider the physical and social opportunity and physical and psychological capability dimensions. The BCW analysis suggested that enablement should be considered for this section of the programme to help address barriers to uptake and engagement.

6.22 Consensus on Pre-programme Information

6.22.1 General health

Four a priori codes and one in vivo code were used to analyse the data from the round one survey to guide the questions about general health: '*current medical history', 'drug history', 'contraindications', 'screening', and 'function*.' The participants suggested two standardized forms to screen general health prior to starting the swimming programme; the aquatic therapy screening form was suggested by the physiotherapists and the PAR Q questionnaire by one of the swimming professionals. Additional questions about general health were also suggested, including asking what might cause a problem in the water, current exercise habits, support getting in and out of the pool and fatigue. It was mentioned that if a swimming professional was unsure whether an individual was safe to start swimming, they could consult a physiotherapist or GP. When the data was integrated from study one and two, new insights were observed based upon the adverse reaction data from study one and the data was congruent with the barriers data from study one and the subthemes, *my barriers to swimming and how I overcome them and how I manage my back pain.* The subtheme, *my barriers and how I overcome them*, discussed how people with CLBP have to consider other conditions when swimming, not just CLBP, supporting the need to collect current medical history. The subtheme, *how I manage my back pain*, discussed how people with CLBP may be on several forms of medication, supporting the need for the collection of drug history. The adverse reaction data from study one had identified that ear and nose and sinus problems were the most common adverse reaction and the subtheme, *my barriers to swimming and how I overcome them*, had highlighted the side effects of chlorine for some swimmers and the need to ask about reactions to chlorine. The barriers data had identified functional barriers relating to worries about falls and slips, difficulty getting changed, walking from the car park to the pool and from the changing room to the swimming pool, supporting the need to ask about levels of function and physical activity.

6.22.2 Back pain

Seven a priori codes and two in vivo codes were used to analyse the data from the round one survey to guide the questions about back pain: '*diagnosis', 'pain', 'aggravating and easing factors', 'how long', 'mobility', 'advice', 'strategies', 'avoid or push too hard' and 'expectations.'* The participants suggested a range of back pain questions. When the data was integrated from study one and two the data was congruent based upon the barriers and enablers data from study one and the subthemes, *understanding my back pain, how my back pain started, more than just back pain, how I manage my back pain and my swimming journey*. The subtheme, understanding my back pain, discussed the range of different back pain diagnoses, supporting the collection of this data. The subtheme, *understanding my back pain*, discussed the different pains people with CLBP might experience and aggravating, and easing factors with CLBP, the subtheme, *how my back pain started*, discussed the length of time with CLBP and the subtheme, *more than just back pain*, discussed the impact on mobility supporting the inclusion of these domains in the questionnaire. The subtheme, *understanding my back pain*, discussed specific advice received from a health professional about their back pain, the subtheme, *how I manage my back pain*, included discussion regarding current coping strategies, and whether they push hard or are cautious with exercise supporting the inclusion of these questions in the questionnaire. 31.3% of participants agreed that they were worried that swimming would make their LBP worse but 50.6% agreed that they believed that swimming would be a good form of exercise for their back, the subtheme, *my swimming journey*, discussed how people had tried swimming with the expectation that it might be beneficial for LBP, supporting the need to ask about expectations of swimming in the questionnaire.

6.22.3 Swimming ability and experience

Six a priori codes and one in vivo code were used and developed to analyse the data from the round one survey to guide the questions about swimming ability and experience: '*ability', 'swimming strokes', 'aquatic breathing', 'entries and exits', 'phobias', 'recent swimming', and 'temperature.'* The participants suggested a range of swimming ability questions. When the data was integrated from study one and two the data was congruent based upon the barriers

and enablers data from study one and the subthemes, *my swimming journey, learning to swim with back pain, my barriers to swimming and how I overcome them, how swimming looks for me, and where I swim.* Study one had identified that 52.4% of participants were able to swim 50m or more and 31.7% agreed that not swimming well was a barrier to swimming, the subtheme, *my swimming journey*, illustrated the range of swimming abilities amongst swimmers. The theme, *learning to swim with back pain*, included the different strokes people found helpful or not so helpful for CLBP and the skills, such as aquatic breathing required when swimming; supporting the need to ask about swimming ability, strokes, and aquatic breathing. 29.3% of participants agreed that it would be difficult to get in and out of the pool, supporting the inclusion of a question about whether a person can enter the water without assistance and what help they would require. 18.3% agreed that they have a fear of water and the subtheme, *my barriers to swimming and how I overcome them*, illustrated that even regular swimmers have fears about swimming. 25.6% of people had been swimming in the last month in study one, supporting the need to ask when they last went swimming. 23.5% agreed they a cold swimming pool was a barrier to swimming and the subtheme, *where I swim*, also discussed water temperature preferences for people with CLBP, supporting the inclusion of a question asking about preferred water temperature.

The integration of the data supported the inclusion of a wide range of questions asking about general health, back pain, suitability for aquatic based exercise and swimming ability and experience. The round two survey proposed the collection of the following pre-programme information; see Table 25.

Table 25: Round two and three table for pre-programme information

Pre-programme information	**Round two**			**Round three**		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Additional general health info	1(1.53)	100	0.52	No		
Swim ability and experience	2(1.60)	100	0.51	No		
About your back pain	3(1.67)	93.33	0.62	No		
PAR Q	4(1.80)	93.33	0.77	No		
Aquatic screening form	4(1.80)	80	0.94	No		

There was at least 70% agreement that either the aquatic therapy screening form or the PAR Q could be used to screen general health, with some additional questions along with questionnaires asking about back pain and swimming ability and experience. In round two the participants raised concerns about the number of questions, they wanted to know who would complete the form; some thought that a medical person should complete the form with the swimmer. In round three there was positive feedback to the plan to use these questionnaires to collect the pre-programme information. Further comments included provision of both hard and online copies; the information collected would allow the class to be tailored to the individual. When mapped onto the COM-B model the pre-programme information would need to consider the psychological and physical capability, and reflective motivation dimensions. The BCW analysis suggested that enablement should be considered for this section of the programme to help address barriers to uptake and engagement.

6.23 Consensus on Delivery of Programme

Three a priori codes were used to analyse the data from the round one survey to guide the delivery of the programme: '*Physiotherapist', 'swimming professional'* and *'expert patient'*. The participants were not directly asked about who could deliver the programme, however the open questions led to several responses; a physiotherapist trained in aquatic therapy, a swimming professional, or a collaboration between these two professionals. When the data was integrated from study one and two new insights were observed based upon the barriers and enablers data and the subthemes, *my swimming journey, my barriers to swimming and how I overcome them, and my swimming community*. The barriers data had identified that 31.3% of participants were worried that swimming could make their LBP worse, and the enablers data had found that 78.1% agreed that they were more likely to go swimming if their health professional had advised them to swim supporting the need for physiotherapy support. The barriers data had also found that 14.8% had agreed that they found that their LBP was worse while swimming, 9.8% had swimming lessons as an adult and 52.4% were able to swim 50m or more, supporting the need for support from a swimming professional. The subtheme, *my swimming journey*, included recommendation of swimming by a physiotherapist and the subtheme, *my barriers and how I overcome them*, included discussion about how involving a swimming professional enabled a better swimming technique and less LBP during swimming, supporting the inclusion of both a physiotherapist and swimming professional in the delivery

of the programme. The subtheme, *my swimming community*, included swimmers with LBP recommending swimming to other swimmers and supporting new swimmers, supporting the inclusion of an expert patient in the delivery of the programme. The integration of the data supported delivery of the programme by a physiotherapist, swimming professional and / or expert patient. The round two survey proposed the following options for who should deliver the programme; see Table 26.

Table 26: Round two and three data for who should deliver the programme

Who should deliver the programme	**Round two**			**Round three**		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Physio and swim teacher /coach	1(1.47)	93.33	0.83	No		
Physio	2(1.87)	80.00	0.74	No		
Expert patient and physio/teacher /coach	3(2.20)	66.67*	1.15**	No		
Swim teacher /coach	4(2.33)	66.67*	0.90	No		

*less than 70% agreement; **greater than 1.0 SD

There was at least 70% agreement that either a physiotherapist and swimming professional or a physiotherapist could lead the programme with the former option having a higher level of agreement. Additional feedback in round two raised concerns from the swimming professionals that physiotherapists are not trained to teach swimming. In round three there was positive feedback to the plan to have both a swimming professional and physiotherapists delivering the programme. It was suggested that the swimming professional could teach the strokes and the physiotherapist could analyse and adapt the stroke based upon an individual's needs. Two participants in the group were concerned that there were greater costs of running the programme with two professionals. When mapped onto the COM-B model the delivery of the programme would need to consider the physical and psychological capability dimensions. The BCW analysis suggested that education, enablement, and training should be considered for this section to increase the participant's knowledge and skills of swimming and pain management, and to help address barriers to uptake and engagement.

6.24 Consensus on Teaching and Coaching Approaches

Seven a priori codes were used to analyse the data from the round one survey to guide the teaching or coaching approach: '*subgrouping back pain', 'increasing physical activity and fun', 'kinaesthetic', 'constructivist', 'technical / instructional', 'visual' and 'exercise and training*.' The participants were not directly asked about teaching or coaching approaches in round one, however the open questions led to several suggestions. When the data was integrated from study one and two some of the data was congruent and new insights were observed based upon the data from the barriers and enablers data and the subthemes, *how I swim with back pain, my goals and motivation, my barriers and how I overcome them, and my training regime*. The subtheme, *how I swim with back pain*, included discussion about the different swimming strategies people used based upon their LBP diagnosis, supporting a subgrouping approach to delivering the programme. The subtheme, *my barriers and how I overcome them*, discussed strategies that the participants used to overcome barriers, supporting the delivery of a constructive approach whereby the swimmer actively constructs what they learn, they problem solve, and the teacher facilitates their learning. 14.8% of participants agreed that they found their LBP was worse while swimming and subtheme, *how I swim with back pain*, discussed adaptations to swimming based upon how their back felt whilst swimming, reducing discomfort whilst swimming; supporting delivering a kinaesthetic approach whereby participants consider how their body feels when they are swimming, and they make changes based upon how they feel. Study one had identified that 52.4% of participants were able to swim 50m or more and subtheme, *my barriers and how I overcome them*, discussed how having lessons was a helpful tool when learning to swim with LBP, supporting a technical or instructional approach to swimming, whereby the aim is to improve swimming technique. The subtheme, *my barriers and how I overcome them*, discussed how video feedback had been a helpful tool for developing swimming technique, this wasn't mentioned by the participants in round one. The enablers data identified that the wider benefits of swimming were common enablers for people with CLBP and the subtheme, *my training regime*, discussed how motivational tools such as watches could direct training, supporting an approach that focused on swimming as a form of exercise and training, encouraging swimmers to monitor progress and set goals, again this wasn't mentioned by the participants in round one. The barriers data had identified that 32.1% of participants agreed that they don't enjoy swimming however the

subtheme, *my goals and motivation,* discussed how they found swimming fun and enjoyable, this enabled regular swimming, supporting the need for a more enjoyable and fun approach when delivering the programme. The integration of the data supported the suggestion of eight different teaching and coaching approaches. The round two survey proposed the following teaching and coaching approaches; see Table 27.

Table 27: Round two and three data for teaching and coaching approaches

Teaching approach	**Round two**			**Round three**		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Subgrouping back pain	1(1.80)	93.33	0.77	No		
Increasing physical activity and fun	2(1.86)	78.57	0.95	No		
Kinaesthetic	3(1.93)	93.33	0.70	No		
Visual	4(2.53)	53.33*	1.12**	No		
Exercise and training	5(2.60)	53.33*	1.06**	No		
Constructivist	5(2.60)	53*	1.06**	No		
Instructional	6(3.00)	60*	1.41**	No		
Technical	7(3.13)	33.33*	0.92	No		

*less than 70% agreement; **greater than 1.0 SD

There was at least 70% agreement that the following three teaching approaches would be suitable for someone with CLBP. An approach that considers the different types of LBP, that may respond differently to different strokes and programs. An approach that focuses on swimming being used to increase levels of physical activity, making swimming fun with less focus on swimming as a form of exercise and less concern about technique. A kinaesthetic approach whereby participants consider how their body feels when they are swimming and make changes to their stroke based upon this feedback. In round three some participants commented that the other teaching approaches could still be considered, for example a visual learner may find a visual approach beneficial and as they develop as swimmers, and they may wish to try other methods. When mapped onto the COM-B model the teaching and coaching approaches would need to consider the psychological capability, physical capability, physical opportunity, and social opportunity dimensions. The BCW analysis suggested that education and training should be considered for this section of the programme to increase the participant's knowledge and skills with regards to swimming and pain management and enablement should be considered to help address barriers to uptake and engagement.

6.25 Consensus on Content of the Session Brief and Debrief, Warmup and Cool Down

6.25.1 Session brief

The following four a priori codes were used to analyse the data from the round one survey to guide the content of the session brief: '*rehabilitation tool', 'concerns', 'what to expect', and 'standard pre-swimming safety brief'.* The participants agreed that it could be helpful to discuss the session plan with the swimmers before they get in the water. The suggestions included a standard swimming session brief and additional information specific to this population. When the data was integrated the findings were congruent based upon the barriers and enablers data from study one and the subtheme, *my barriers and how I overcome them,* from study two. The barriers data had identified that 44.5% of the participants felt uncomfortable wearing a swimming costume, 31.3% agreed that they were worried that swimming would make their LBP worse, however the enablers data found that 50.6% of participants believed that swimming was good for their back. The subtheme, *my barriers and how I overcome them,* from study two included discussion of barriers and methods of overcoming barriers. The integration of the data supported including a discussion about concerns, fears, and barriers and what to expect during the session and the round one survey data supported discussion about swimming being used as a rehabilitation tool and a standard pre-swimming safety brief. The round two survey proposed the following content in the sessions brief; see Table 28.

Table 28: Round two and three data for session brief

Session brief	**Round two**			**Round three**		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Concerns, fears, & barriers	1(1.40)	100	0.51	No		
What to expect	1(1.40)	100	0.51	No		
Rehabilitation tool	2(1.67)	86.67	0.72	No		

In addition to a standard pool session safety brief, there was at least 70% agreement that the following items could be included in the session brief for the programme. There should be an opportunity to discuss any concerns, fears, and barriers in relation to LBP, swimming or being in the water and a chance to talk about their expectations; what do they want to achieve from the session. There should also be an explanation as to why swimming is being used as a

rehabilitation tool, the benefits, and problems with this type of approach, any guidelines, and the wider benefits of swimming. In round three there was positive feedback to the plan to include all three aspects in the session brief; feedback included that some of this information could be provided before the session. When mapped onto the COM-B model the session brief would need to consider the psychological capability and reflective motivation dimensions. The BCW analysis suggested that education should be considered for this section of the programme to increase the participant's knowledge and understanding of using swimming as a rehabilitation modality before the session.

6.25.2 Session debrief

The following five in vivo codes were developed to analyse the data from the round one survey to guide the content of the session debrief: *'expectations', 'teaching points', 'positive feedback', 'what to work on'* and *'reflection'*. The participants made several suggestions, the debrief could be a time for swimmers to reflect on the session, to discuss what they expected to achieve versus what they achieved during the session, what went well, what they enjoyed, what was more challenging, and what they disliked. The participants suggested that the debrief could cover any teaching points which were difficult to communicate while in water or as a group and advise how the swimmers might expect to feel after the session. The debrief could include teaching points to work on before the next session and provide a forum for positive feedback. When the data was integrated from study one the findings were congruent. The barriers data had identified that 21% of participants had agreed that they found that their LBP was worse after swimming however the enablers data identified that 23.5% agreed that swimming eased their LBP. The integration of the data supported the inclusion of expectations during the session debrief and the data from the round one survey supported the inclusion of teaching points, positive feedback, what to work on before the next session and reflection on the session. The round two survey proposed the following content in the sessions debrief; see Table 29.

Table 29: Round two and three data for session brief

Session debrief	**Round two**			**Round three**		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
What to expect after session	1(1.40)	100	0.51	No		

Teaching points	1(1.40)	100	0.51	No		
Positive feedback	1(1.40)	93.33	0.63	No		
What to work on before next session	2(1.47)	100	0.52	No		
Reflection on session	3(1.62)	94.00	0.62	Yes	100	0.50

There was at least 70% agreement that the following activities could be included in the session debrief; talking about what to expect after the session, covering any teaching points, positive feedback from the teacher, what to work on before the next session and reflection on the class. Additional comments in round two included caution that some swimmers might want reflections to be personal, therefore they should not be encouraged to share reflections with others. It was suggested that the focus should be on what went well. The wording for the reflection section was changed based upon these comments so that the participant would not share reflections in the class; at least 70% of the participants agreed with these changes. Feedback in round three included the option for participants to provide private feedback via email. When mapped onto the COM-B model the session debrief would need to consider the psychological capability, physical capability, and reflective motivation dimensions. The BCW analysis suggested that education, persuasion, and training should be considered for this section of the programme to increase the participant's knowledge, skills and understanding of using swimming as a rehabilitation modality and using communication to induce positive feelings after the session.

6.25.3 Warmup

Seven a priori codes were used, and two in vivo codes were developed to analyse the data from the round one survey to guide the content of the warmup: '*water based', 'land-based warm up', 'both water and land-based warm up', 'lack of evidence', 'mind-body exercise', 'core aquatic skills', 'stretches', 'low intensity swimming' and 'exercise to raise the heart rate*.' A greater proportion of participants preferred a water-based warm-up compared to a combined land and water-based warm-up; one physiotherapist questioned lack of evidence supporting warm-ups before swimming. The feedback regarding a land-based warm-up included concerns about body confidence, safety issues and risk of tripping for those with mobility issues. The swimming professionals reported being less confident with land-based warm-ups for this population due to restricted medical knowledge. They suggested if the

swimmer used their home exercises to warm up, it could give the teacher an indication of the level of pain. It was suggested that a land-based warm up could be conducted in the gym or at home before arriving at the pool. The participants thought that warming up in the water was better as the weight of the body would be supported in the water, there would be less pressure, the water would provide resistance and it would support movement. It was suggested that a water-based warm-up would allow the swimmer to get used to the feel, temperature, and smell of the water. Suggestions included walking, jogging, and jumping in the water, sculling, easy front crawl and backcrawl, stretches and awareness activities including getting used to the sensation of the water. When the data was integrated from study two the findings were congruent, based upon the subtheme, *my training regime.* This subtheme included warmups used in the water and on land before swimming, for example incorporating low intensity swimming, stretches in the water, and home exercises before swimming. Not all swimmers did a warmup but reflected that maybe they should consider doing one. The integration of the data supported the inclusion of low intensity swimming, and stretches, and the data from the round one survey supported the inclusion of awareness activities, walking in the water, relaxation, floating and sculling and light jogging. The round two survey proposed the following content in the warmup; see Table 30.

Table 30: Round two and three data for warm up

Warm-up	**Round two**			**Round three**		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Awareness activities	1(1.67)	93.33	0.62	Yes	69.23*	0.81
Walking in water	2(1.69)	94.00	0.60	No		
Relaxation, floating, sculling	3(1.80)	93.33	0.56	No		
Stretches	4(1.93)	80.00	0.70	No		
Low intensity swimming	5(2.13)	81.00	0.72	No		
Light jogging	6(2.63)	68.75*	1.02**	No		

*less than 70% agreement; **greater than 1.0 SD

There was at least 70% agreement that the following activities could be included in the warm-up; awareness activities, walking in the water, relaxation, floating and sculling, stretches and easy low intensity swimming. There was less than 70% agreement and a wider range of responses that light jogging should be included in the warmup. Further feedback in round two included that the warm-up should be specific to the individual, the instructor should take care with language. Based upon feedback in round two in round three the wording in the

awareness activities section was changed to lengthening through spine to trunk; there was less than 70% consensus that the term trunk lengthening should be used during the awareness activity. Additional recommendations in round three included trying different approaches to the warm-up, to enable the swimmers to find their preferred warm up. When mapped onto the COM-B model the warmup section would need to consider the physical and psychological capability dimensions. The BCW analysis suggested that education and training should be considered for the warmup section of the programme to increase the participant's knowledge and skills with regards to swimming and pain management.

6.25.4 Cool down

Five a priori codes were used, and one in vivo code was developed to analyse the data from the round one survey to guide the content of the cool down: '*stretches', 'mind-body exercise', 'core aquatic skills', 'low intensity swimming', 'exercise to lower the heart rate' and 'fun exercises*.' Suggestions for the cooldown were similar to the warmup, they included easy swimming, walking in the water, gentle stretching, specific physiotherapy stretches, kicking, floating, star floats, sculling on back with or without breaststroke kick, breathing, relaxation, floating on back, meditation type breathing exercises, Old English backstroke, gentle movements with a fun element, changing the stroke to the main set for example if front crawl practised in main set then sculling on the back could be used to cool down. There was no data to integrate from study one or study two for this section; the round one survey data supported the inclusion of stretches, walking in the water, sculling, low intensity swimming and old English backstroke in the cool down. The round two survey proposed the following content in the cool down; see Table 31.

Table 31: Round two and three data for cool down

Cool down	**Round two**			**Round three**		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Stretches	1(1.75)	88.00	0.68	Yes	92.86	0.63
Walking in water	1(1.75)	94.00	0.58	No		
Sculling	2(1.80)	93.33	0.56	No		
Low intensity swimming	3(1.87)	86.67	0.83	No		
Old English backstroke	4(2.33)	53.33**	1.18*	No		

*less than 70% agreement; **greater than 1.0 SD

There was at least 70% agreement that the following cool down activities could be included; stretches, walking in the water, sculling and easy swimming. There was less than 70% level of agreement and a wider range of responses that Old English Backstroke should be included. Further feedback in round two included that the cool down should be fun and relaxing and include stretching. One participant advised against checking whether flexibility had improved during the stretches, as swimming could be beneficial but might not enable improved flexibility. Based upon this feedback the wording on the stretching section was changed to does the movement feel easier compared to the start of the session; at least 70% of the participants agreed with these changes. When mapped onto the COM-B model the cool down section would need to consider the physical and psychological capability, and automatic motivation dimensions. The BCW analysis suggested that education and training should be considered for the cool down section of the programme to increase the participant's knowledge and skills with regards to swimming and pain management.

6.26 Consensus on Teaching the Core Aquatic Skills

Seven a priori codes were used, and three in vivo codes were developed to analyse the data from the round one survey to guide the content of the core aquatic skills section: '*coping', 'safety', 'changing position', 'hybrid strokes', 'floating', 'sculling', 'treading water', 'aquatic breathing', 'gliding' and 'awareness exercise'*. The participants suggested different core aquatic skills which could be included in the programme, they discussed how the choice would depend on the experience and ability of the swimmer. Most skills aligned with the core aquatic skills recommended by the STA (2018) and Swim England (2019); additional skills suggested included being able to cope with a painful episode when swimming which links with water safety and awareness exercises.

When the data was integrated from study one and two some of the data was congruent and new insights were observed based upon the barriers data and the subthemes, *how I swim with back pain, where I swim, my training regime, my barriers to swimming and how I overcome them, and my feelings about swimming*. 14.8% of participants in study one agreed that they found that their CLBP was worse when swimming, supporting the need for including the skill of learning how to cope with a painful episode while swimming. 29.3% of participants agreed that they would find it difficult to get in and out of the pool and the subtheme, *where*

I swim, supporting the inclusion of learning entries and exits from the pool. The subtheme, *how I swim with back pain*, discussed difficulties changing position in the water when turning, supporting the inclusion of learning the skill of changing position. The subtheme, *how I swim with back pain*, supported the value of hybrid strokes and the subtheme, my training regime, included sculling, supporting the inclusion of these skills. The subthemes, *my training regime*, and *my barriers to swimming and how I overcome them*, supported the importance of including aquatic breathing and the subtheme*, my feelings about swimming*, supported the inclusion of awareness exercises. There was no data to integrate for the skills of learning to tread water, floating and gliding. The integration of the data supported the inclusion of learning how to cope with a painful episode whilst swimming, entries and exits, changing position in the water, hybrid strokes, sculling, aquatic breathing, awareness exercises, and the data from the round one survey supported the inclusion of learning to tread water, floating and gliding.

The round two survey proposed the following core aquatic skills; see Table 32.

Table 32: Round two and three data for core aquatic skills

Core aquatic skills	**Round two**			**Round three**		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Coping with a painful episode	1(1.40)	100	0.51	No		
Water safety: entries and exits	2(1.53)	100	0.52	No		
Learning to change position in the water	2(1.53)	100	0.53	No		
Trying hybrid strokes	2(1.53)	100	0.52	No		
Learning to float	3(1.60)	100	0.51	No		
Developing a feel for the water	3(1.60)	93.33	0.63	No		
Learning how to tread water	4(1.73)	93.33	0.59	No		
Breathing exercises including mindful breathing	4(1.73)	86.67	0.88	No		
Learning to glide and move in a streamline way	5(1.79)	93.33	0.80	No		
Awareness exercises	6(1.80)	87.50	0.83	Yes	85.71	0.60

There was at least 70% agreement that all the suggested aquatic skills could be included in the programme. In round two with reference to the awareness exercise, one participant

suggested that instead of focusing on having less pain in the water, it would be better to focus on what they are achieving instead. Based upon this feedback the wording of the awareness activity was changed, at least 70% of the participants agreed with this change. In round three feedback included the importance of language and not drawing attention to the pain. When mapped onto the COM-B model the core aquatic skills would need to consider the psychological and physical capability dimensions. The BCW analysis suggested that education and training should be considered for this section of the programme to increase the participant's knowledge and skills about swimming.

6.27 Consensus on Teaching and Coaching Swimming Strokes

Three a priori codes were used, and twelve in vivo codes were developed to analyse the data from the round one survey to guide the teaching of all the swimming strokes: '*unsure of stroke', 'hybrid strokes', 'no stroke preference', 'mixing of strokes', 'head position', 'problem solving', 'breathing', 'streamline swimming', 'rotation', 'undulation', 'arch in back', 'body alignment', 'lengthening through spine', 'language',* and *'nerve damage*.' Most participants in the round one survey agreed that butterfly would not be a suitable stroke for someone with CLBP, but front crawl, backstroke and breaststroke could be included in the programme. Some participants suggested that front crawl and backstroke would be better strokes to learn and use than breaststroke which can be undulating and ballistic. Other participants suggested that movement was the most key factor with swimming, it did not matter which stroke was practised or taught. Some participants suggested that adapting the stroke and position in the water could be helpful and others felt that no changes should be made. The physiotherapists spoke about starting with low level swimming, little and often, building up gradually, problem solving, adjusting, and re-evaluating, they reported that there was no evidence for adapting strokes and advised against language which might reinforce fear avoidant behaviours. The swimming professionals discussed the technical aspects of swimming; including the impact of head position on the lumbar area and the importance of body position, aiming to adopt a relaxed position lower in the water at an angle rather than in line with the water surface. The people with CLBP discussed how they naturally adjusted their stroke to fit their comfort and ability, when discussing butterfly and breaststroke they referred to pressure in the lumbar region. They agreed that focusing on the head position and breathing was important with front crawl, and hybrid strokes could help people get moving.

When the data was integrated from study one and two some of the data was congruent, some data was divergent and new insights were observed based upon the barriers data and the subthemes, *how I swim with back pain, my barriers to swimming and how I overcome them, my training regime, and how my back feels when I swim*. The barriers data from study one found that 79.7% of participants were unsure which stroke was best for CLBP, however there was no mention of this uncertainty in study two or in the round one survey. The subtheme, *how I swim with back pain*, was divergent with regards to the suggestion in the round one survey that there was no preference over which stroke could be used, the participants in study two reported having a stroke preference for their back. The subtheme, *how I swim with back pain*, was congruent with the recommendation of hybrid strokes such as old English backstroke, mixing the strokes, being streamline when swimming, adapting for nerve damage and taking a problem-solving approach. The subthemes, *how I swim with back pain* and *my barriers to swimming and how I overcome them*, were congruent for considering the head position when swimming. The subthemes, *how I swim with back pain*, and *how my back feels when I swim*, were congruent with the recommendation of considering rotation, the arch in the low back and the body alignment when swimming. The subthemes, *my training regime*, and *my barriers to swimming and how I overcome them*, was congruent with considering breathing style when swimming. There was no reference to undulation or being careful of language which could promote avoidant behaviour when teaching swimming in study one or two, however it was suggested that these factors should be considered in the round one survey. The subtheme, *how I swim with back pain*, had mentioned finding lengthening through the spine beneficial, however this was not discussed in the round one survey. When mapped onto the COM-B model the psychological and physical capability dimensions would be needed when considering the teaching of the swimming strokes. The BCW analysis suggested that education and training should be considered for this section of the programme to increase the participant's knowledge and skills about the swimming strokes.

This section has now been divided into the three strokes: front crawl, backstroke, and breaststroke

6.27.1 Front crawl

Four a priori codes were used to analyse the data from the round one survey to guide the teaching of front crawl: *front crawl best stroke, adapting front crawl, avoidance, or caution with front crawl, and front crawl drills*. When the data was integrated with study two, the subthemes, *how I swim with back pain* and *how my back feels when I swim*, were congruent with the suggestion that front crawl was the best stroke for people with CLBP, that for some people the stroke could be adapted to lessen discomfort, for some people there was the need for caution with the stroke but not avoidance and that swimming drills or exercises could be used alongside this stroke. The integration of the data supported the inclusion of breathing exercises, problem solving, learning to adapt swimming for nerve damage, learning to become more streamline, learning to improve rotation, considering the head position, increasing the feeling of length through the spine, and learning to swim with a low body position in the water.

The round two survey proposed the following front crawl teaching points, drills, and exercises; see Table 33.

Table 33: Round two and three data for front crawl teaching points, drills, and exercises

Front crawl	**Round two**			**Round three**		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Breathing exercises, different head positions when taking breath, discover best method	1(1.60)	100	0.63	No		
Problem solving trialling different positions, learning how to make stroke more comfortable for back	2(1.67)	93.33	0.82	No		
Learning to adapt swimming for nerve damage	3(1.87)	93.33	0.52	No		
Learning to become more streamline	4(2.07)	86.67	0.80	No		
Learning to improve rotation	5(2.20)	86.67	0.86	No		
Head position, taking care not to swim with head too high in the water	6(2.27)	73.33	1.1**	Yes	92.86	0.51
Increasing the feeling of length through spine when swimming	7(2.44)	75.00	1.09**	No		

Learning to swim with a low body position in water	8(2.90)	44.00*	0.89	No		

*less than 70% agreement; **greater than 1.0 SD

There was at least 70% agreement that breathing exercises, problem solving, adapting swimming for nerve damage, learning to be streamline and improving rotation could be included in the programme. Although there was at least 70% agreement, there was a wider range of responses for learning to swim with head looking down and enhancing length through spine during stroke and less than 70% agreement for learning to swim with a lower body position in the water. The feedback from the participants in round two included advising placing less emphasis on length through the spine. The participants had different views on the best head position when swimming and advised caution against unhelpful messages about posture and the spine and using problem solving with newer swimmers until their confidence has grown. Some participants suggested that some of the swimming drills were not appropriate for this population. Based upon the comments in round two the section on head position was changed to practising different head positions whilst swimming, taking care not to swim with head too high in the water, feeling how different positions affect their neck, body position and back and the sections on lengthening and body positions were removed.

6.27.2 Backstroke

Four a priori codes were used to analyse the data from the round one survey to guide the teaching of backstroke: backstroke best stroke, adapting backstroke, avoidance, or caution with backstroke, and backstroke drills. When the data was integrated with study two, the subthemes, *how I swim with back pain* and *how my back feels when I swim*, were congruent with the suggestion that backstroke was the best stroke for people with CLBP and that there was no need to adapt the stroke to lessen discomfort. There was no mention of avoidance or caution with backstroke in the round one survey, however the subthemes, *how I swim with back pain* and *how my back feels when I swim*, were divergent in that there was the suggestion of caution swimming backstroke outdoors because of sighting difficulties and some people may struggle to keep the centre of the body up when swimming this stroke which could cause discomfort. The data from the round one survey suggested swimming drills or exercises could be used alongside this stroke. The integration of the data supported the inclusion of problem solving, breathing exercises, learning other forms of backstroke, considering head position,

learning to use the flags, learning to improve rotation, and learning to swim with the body on the surface of the water.

The round two survey proposed the following backstroke teaching points, drills, and exercises; see Table 34.

Table 34: Round two and three data for backstroke teaching points, drills, and exercises

Backstroke	Round two			Round three		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Problem solving trialling different positions, learning how to make stroke more comfortable for back	1(1.87)	93.33	0.74	No		
Breathing exercises, discover best method	1(1.87)	86.67	0.64	No		
Learning other forms of backstroke	1(1.87)	86.67	0.64	No		
Learning with head looking up to ceiling, relax neck	2(2.00)	80.00	0.65	No		
Learning to use the flags	2(2.00)	86.67	0.76	No		
Learning to improve rotation	3(2.19)	75.00	0.54	Yes	71.43	0.67
Learning to swim with body on surface of water	4(2.50)	56.00*	0.82			

*less than 70% agreement

There was at least 70% agreement that problem solving, breathing exercises, trying other forms of backstroke, learning to swim with head looking up, learning to use the flags, and improving body rotation could be included. There was less than 70% agreement that learning to swim with the body on the surface of the water should be included, so this would not be included. Further feedback in round two included that the body position during this stroke would depend on the individual.

6.27.3 Breaststroke

Four a priori codes were used to analyse the data from the round one survey to guide the teaching of breaststroke: breaststroke best stroke, adapting breaststroke, avoidance, or caution with breaststroke, and breaststroke drills. When the data was integrated with study two, the subthemes, *how I swim with back pain* and *how my back feels when I swim*, were congruent with the suggestion that breaststroke was the best stroke for some people with

LBP, that there was no need to adapt the stroke to lessen discomfort but improvements in technique could be beneficial and that head up breaststroke should be avoided. When the data was integrated with subthemes, *my barriers and how I overcome them* and *how my back feels when I swim*, new insight were observed including avoidance of the stroke based upon recommendations from health professionals, discomfort with the stroke due to knee problems, avoiding the stroke during a flare up or early during the session, and discomfort due to the position of the low back during the stroke. The data from the subtheme, *how I swim with back pain*, was congruent for the drills and exercises to lessen discomfort during breaststroke suggested for this stroke in the round one survey. The integration of the data supported the inclusion of breathing exercises, problem solving, considering the head position, trying different ratios of kick to pull, practising kick on the back, trying a stroke with more or less undulation, experiencing swimming underwater and learning a flatter stroke.

The round two survey proposed the following breaststroke teaching points, drills, and exercises; see Table 35.

Table 35: Round two and three data for breaststroke teaching points, drills, and exercises

Breaststroke	**Round two**			**Round three**		
	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Breathing exercises, discover best method	1(1.60)	100	0.51	No		
Problem solving trialling different positions, learning how to make stroke more comfortable for back	2(1.69)	94.00	0.60	No		
Trying different head positions during stroke cycle	3(1.81)	94.00	0.54	No		
Trying different ratios of kick to pull	4(1.93)	86.67	0.80	No		
Practising kick on back	5(2.00)	81.00	0.97	Yes	78.57	0.65
Trying stroke with more or less undulation	6(2.06)	81.25	0.57	No		
Experiencing swimming underwater	7(2.07)	78.57	0.62	Yes	78.57	0.65
Learning a flatter stroke with slower stroke turnover, longer glide and wedge kick	8(2.19)	81.00	0.83	Yes	78.57	0.65

There was at least 70% agreement that breathing exercises, problem solving, trialling different head positions and kick to pull ratios, practising the kick on their back, trying different amounts of undulation, experiencing swimming under the water, and learning a flatter stroke with a slower turnover should be included. Further comments in round two included less focus on how the stroke affects the back so not promoting hypervigilance and not assuming that less lumbar extension is better. Based on these comments the wording was changed aiming to balance the need for some awareness of the back but not promoting hypervigilance.

6.27.4 Butterfly

Four a priori codes were used to analyse the data from the round one survey to guide the teaching of butterfly: '*butterfly best stroke', 'adapting butterfly', 'avoidance, or caution with butterfly', and 'butterfly drills*.' There was no data in the round one survey to suggest that butterfly would be the best stroke for someone with CLBP. When the data was integrated with subthemes, *my barriers to swimming* and *how I overcome them*, it was noted that there were some adaptations to butterfly which could make the stroke more suitable for some people with CLBP. When the data was integrated with the subtheme, *how my back feels when I swim*, the data was congruent for avoiding or being cautious with swimming butterfly. The participants in the round one survey did not suggest butterfly drills or exercises, however, the subtheme, *how I swim with back pain*, had identified that butterfly kicking in supine could be helpful for some people with CLBP. Based upon the data from study two and the round one survey it was decided that butterfly would not be included in the swimming programme.

6.28 Consensus on Strategies to Enable People with CLBP to Become Regular Swimmers

Three a priori codes were used, and eleven in vivo codes were developed to analyse the data from the round one survey to guide the strategies to enable people with CLBP to become regular swimmers: *'fun sessions', 'discount', 'pool information', 'peer support', 'reflection', 'session with family and friends', 'goal setting and action plans', 'feedback', 'signposting to specific sessions', 'drop-in sessions', 'integration', 'prompts',* and *'signing up to challenges*.' The participants in round one suggested a variety of strategies which might encourage a person to become a regular swimmer. When the data was integrated from study one and two some of the data converged, some data was divergent and new insights were observed based upon the data from study one and the subthemes, *my swimming community, my feelings about*

swimming, swimming improves my physical and mental health and functional benefits gained through swimming, my goals and motivation, and developing a swimming habit. The barriers data whereby 32.1% of participants agreed that they didn't enjoy swimming and the subthemes, *my swimming community,* and *my feelings about swimming*, supported the inclusion of a fun and enjoyable element to swimming. 37.8% of participants in study one agreed that the cost of swimming would prevent them from swimming, supporting the provision of discounted sessions. The data from study one identified common swimming preferences in this population, supporting the provision of information about local pools. The subtheme, *my swimming community*, supported the provision of group swimming, encouraging peer support, however, in contrast the enablers data from study one identified that only 13.5% of participants agreed that they would like to make new friends through swimming. The subtheme, *swimming improves my physical and mental health and functional benefits gained through swimming*, supported the need for time to reflect on the benefits of swimming, beyond back pain. The subtheme, *my swimming community*, also supported the need for positive feedback from the person leading the sessions. None of the participants in round one mentioned specific sessions for men or women or adults, in contrast this was a strong preference in the survey in study one, whereby 91.0% of participants said that they would prefer to attend an adult only session. 42.0% of female participants and 8.0% of male participants said they would prefer to attend a swimming session with just female or just male swimmers; the subtheme, *my swimming community*, also mentioned adult only sessions. Furthermore, the participants in round one did not mention providing a session with friends and family, in contrast, the enablers data had identified that 71.1% agreed that they enjoyed swimming with friends / family, and this would encourage them to swim and 66.7% of participants already take their children, a relative or friend swimming. The subtheme, *my swimming community*, also included discussion of swimming with family members. 76.7% agreed that they lacked motivation to go swimming and 82.0% agreed that setting goals and making an action plan could help them go swimming more regularly and the subtheme, *my goals and motivation*, supported the use of goal setting and action plans and further drop-in sessions. The subtheme, *my swimming habit*, suggested a regular swimming session could enable swimming, supporting the integration of the programme with local structured sessions. 76.7% agreed that they lacked motivation to go swimming, supporting the suggestion of prompts such as a text to book a swim. There was no data in study one or two

to support the provision of paperwork to support learning after the programme. No one in round one mentioned signing up for challenges, in contrast the subtheme, *my goals and motivation*, suggested that this might be a useful tool to enable regular swimming. The integration of the data supported the inclusion of making swimming fun, enjoyable and sociable, offering discounted swimming, providing information about access to local pools, developing a peer support group, reflecting on the benefits of swimming, providing encouragement and positive feedback, signposting to sessions for only adults or men or women, providing a session for a family member or friend, setting goals and making an action plan, providing further drop-in sessions, integrating with a local class, sending emails or text reminders, providing paperwork to support learning and signing up for challenges.

The round two survey proposed the following strategies to enable people with CLBP to become regular swimmers; see Table 36.

Table 36: Round two and three data for strategies to enable people with CLBP to become regular swimmers

	Round two			**Round three**		
Keeping going with swimming	Rank (mean)	Agreement (%)	SD	Changes	Agreement (%)	SD
Making swimming fun, enjoyable, sociable	1(1.44)	100	0.51	No		
Discounted swimming	2(1.47)	100	0.52	No		
Information access to local pool	3(1.53)	100	0.52	No		
Developing a peer support group	4(1.60)	100	0.51	No		
Time to reflect on the benefits	4(1.60)	93.33	0.63	No		
Encouragement and positive feedback	4(1.60)	93.33	0.63	No		
Signpost sessions for only adults or men or women	5(1.80)	86.67	0.86	No		
Session with family / friend	5(1.80)	80.00	0.77	No		
Setting goals and action plan	6(1.87)	80.00	0.92	No		
Further drop-in sessions	6(1.87)	73.33	0.99	No		
Integration with local classes	7(2.13)	66.67*	0.92	No		
Emails / text reminders	8(2.31)	63.00*	0.79	No		
Paperwork to support learning	9(2.47)	47.00*	0.99	Yes	60.00*	0.47
Signing up for challenges	10(2.56)	50.00*	0.96	No		

*less than 70% agreement

There was at least 70% agreement that the following strategies to enable people with CLBP to become regular swimmers on completion of the programme. Making swimming sessions fun, enjoyable and sociable, offering discounted swimming, providing information about local pools, developing a peer support group using social media, taking time to reflect on the other benefits of swimming, providing encouragement and positive feedback, signposting swimmers to session for adult only, only men or only women, offering a session whereby a friend or family member could join them in the water, setting goals and making an action plan and offering further drop in sessions. There was less than 70% agreement that the following strategies should be used; integrating with a regular session in the local pool, email or text reminders, paperwork to support the session and signing up for a swimming challenge. Participants commented that an online app might be better than paperwork; but in round three less than 70% of participants agreed that an app would enable people to become regular swimmers. Further feedback in round three included that people are overloaded with apps, and another suggested that it should be optional, as some may prefer paperwork.

When mapped onto the COM-B model this section on strategies to enable people with CLBP to become regular swimmers would need to consider the psychological capability, physical capability, physical opportunity, social opportunity, and reflective motivation dimensions. The BCW analysis suggested that education, enablement, environmental restructuring, modelling, persuasion, and training should be considered for this section of the programme to increase the participant's knowledge and skills of using swimming as a rehabilitation modality, to use communication to induce positive feelings about swimming, to change the physical and social context when providing swimming, to provide peer support and to reduce the barriers to becoming a regular swimmer.

6.29 Swimming Programme

Table 37 summarises the swimming programme developed during the three rounds of this study.

Table 37: Swimming programme

Swimming Programme
Programme set up
Average length of session 30 minutes
Frequency of sessions 1-2 a week
Average group size five people
Pre-programme information
Health questionnaire, based on aquatic therapy screening form, PAR Q alongside additional questions about general health, see Appendix 8
Back pain questionnaire, see Appendix 9
Swimming ability and experience questionnaire, see Appendix 10
Delivery of programme
A collaboration between a physiotherapist and swimming teacher or coach
Teaching and coaching approaches
A kinaesthetic (problem-solving) approach whereby participants consider how their body feels when they are swimming and make changes to their stroke based upon how they feel.
Subgrouping approach An approach that takes into account the different types of back pain, that may respond differently to different swimming strokes and programs.
Increasing levels of physical activity and fun approach that focuses on swimming being used to increase levels of physical activity, making swimming fun with less focus on swimming as a form of exercise and less concern about technique.
Session brief
Discuss any **concerns, fears, and barriers**; in relation to back pain, swimming or being in the water.
Discuss **what to expect** and what is normal during and after a swim. They might experience some discomfort, mild shortness of breath and muscle fatigue; they should alert the teacher if they experience a significant increase in back pain or they feel unwell. Discuss pacing and when they should rest /pause between activities or lengths. Discuss their expectations; what do they want to achieve from the session.
Explain why using **swimming as a rehabilitation tool**, the benefits, and problems with this type of approach and any guidelines. Include some discussion about not knowing which swimming stroke is best for back pain. Hopefully by the end of the class the swimmers will have developed a better understanding of what stroke(s) are best for their back. Also talk about the wider benefits of swimming such as impact on weight and mental health and how this could help in the management of their back pain.
Warmup

Awareness activities: Awareness activities including getting used to the sensation of the water and the feeling of weightlessness, how does this impact on movement and breathing. Feeling the sensation of their spine lengthening when moving through water. Bringing an awareness to their breathing using techniques and exercises. Acclimatisation to the water temperature, if the session is in different settings feeling what water temperature is best for their back.
Walking in water: Walking in the water different directions, different speeds, with or without floatation aids, walking while doing sculling movements with arms.
Relaxation, floating, sculling
Stretches: Stretches in the water for back, neck, arms, and legs, including usual physio stretches. Finding out whether it is better for back to do stretches when they first get in pool or after some low intensity swimming.
Easy swimming: Start with easy / low intensity swimming (front crawl and backstroke), gradually increasing intensity. Finding out whether it is better for them to warm up alternating strokes or with just one stroke.
Core aquatic skills
Learning how to cope with a painful episode when swimming, being able to indicate when they need support. Being able to get to the side or shallow water independently.
Water safety, how to enter and exit the water, learning to make adjustments, trying different methods to reduce discomfort or accommodate for back pain, loss of strength and mobility. This could include using steps, sliding in, using ramps or hoists.
Learning to change position in water (e.g., from front to back), using the core muscles during these transitions and relaxing the spine to allow it to move freely. Being aware how this feels different in the water when compared to being on dryland. Practicing different ways of turning at end of length, finding out which feels more comfortable. If nerve damage affecting one leg, then look at how could modify push off wall.
Trying **hybrid strokes** if standard strokes do not agree with them, looking at different combinations of arm propulsion, kick, and body positions, which combination feels best for them. This could be considered if issues with other joints, such as shoulders or knees.
Learning to float, trying different head, body, arm, and leg positions in water, feeling which ones are more comfortable for their back. Learning to relax while floating in the water. Learning how to stretch whilst floating. Using floating to increase core strength. Using floating to deal with panic in the water or if experiencing cramp. Using equipment to support body whilst floating.
Developing a **feel for the water** with hands through sculling, feeling how core muscles are recruited with this movement, trying sculling in different positions (on back, on front and vertical).
Learning how to tread water and jog in deep water with a float, trying different arm and leg movements, feeling which movements are more comfortable for back.
Breathing exercises with head out and in the water, mindful breathing, compare breathing out through mouth and nose, compare different speeds of inhalation and exhalation. Develop an awareness of how body feels with different styles of breathing, discover which variation feels more comfortable for back and breathing. Discuss concerns about putting face in water such as feeling claustrophobic. Learning how to fit and wear goggles so able to relax when breathing in water. Learn how breathing exercises can be used to manage anxiety, pain, and focus on the present moment.
Learning to glide and move in a streamline way, trying different head, body, arm, and leg positions in the water, feeling which ones are more comfortable for back and which improve the efficiency of the movement through the water.
Awareness exercise: do they feel more confident moving in the water than on land, can they do more in the water, do they have less fear of movement, does their back feel different in the water, do they have less back pain in the water, do their muscles feel more relaxed in the water, do they feel that the water is providing support for their back? Trying different movements that

they struggle with on land in the water, if this movement feels easier, practising it in water. Learning to be in the present moment during swim.
Swimming strokes: teaching points and drills / exercises
Front crawl
Breathing: Being mindful to exhale in the water and to inhale the normal amount of air, not hyperventilate. Practising different intervals when taking a breath. Compare breathing through mouth and nose. Practise different speeds of inhalation and exhalation. Compare different head positions when taking breath to the side. Discover which variation feels more comfortable for back and for breathing.
Problem solving: Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back.
Nerve damage: If unable to use legs whilst swimming (e.g., due to nerve damage) finding ways to swim and keep in a streamline position either with floats, using core or increasing speed. If nerve damage only affecting one leg, find out whether better for back to use just one leg or no legs.
Streamline: Learning how to adopt a more streamline position in the water for their body so that less effort required to swim, adding a pull buoy or flotation trunks if required so swimming close to surface.
Rotation: Improving rotation of the trunk so that the whole body rotates, learning to breathe both sides if possible. Learning to move smoothly through water using this rotation. Drills to enhance rotation could include 6 kicks and roll and a single-arm drill. Do they feel better using front crawl to improve the rotation in spine or is it more comfortable to rotate the whole body?
Head position: Practicing different head positions whilst swimming front crawl, taking care not to swim with the head too high in the water, feeling how different positions affect their neck, body position in the water and back.
Backstroke
Problem solving: Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back.
Breathing: Being mindful to exhale through nose so water does not enter nose whilst on back and to inhale the normal amount of air, not hyperventilate. Practising different intervals when taking breath with stroke. Practise different speeds of inhalation and exhalation. Discover which variation feels more comfortable for back and for breathing.
Other forms of backstroke: Learning alternative ways to swim on back such as old English backstroke (breaststroke kick and double arm pull) or sculling with breaststroke or flutter kick, being aware how back feels with different versions of stroke.
Head position: Learning to swim backstroke with head looking up, not down the pool to relax neck muscles and to reduce sinking of legs, being aware how head position changes low back position whilst swimming. Learning to follow ceiling or if outside shore or bank to reduce disorientation in this position and to keep swimming course straight.
Using the flags: Learning how to use the flags when swimming backstroke so able to judge how close to the end and therefore allowing the swimmer to stay on their back and relax when swimming this stroke
Rotation: Learning how to improve rotation of body during backstroke. Being aware how this could increase the feeling of lengthening through the trunk and improve the efficiency of the arm pull. Do they feel better using back stroke to improve the rotation in the spine or is it more comfortable to rotate the whole body? Using this rotation to move smoothly through water. Drills: single arm pull, not over kicking, kick only to keep legs in correct position in water
Breaststroke
Breathing: Being mindful to exhale in the water and to inhale the normal amount of air, not hyperventilate. Practising different lengths of glide, which will affect intervals when taking a breath and different speeds with stroke transitions (e.g., from pull to glide). Compare breathing

through mouth and nose. Practise different speeds of inhalation and exhalation. Discover which variation feels more comfortable for back and for breathing.
Problem solving trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back.
Head position: Practising different head positions during the stroke cycle, allowing the head to dip to relax neck muscles when face in the water, feeling how different positions effect their neck and back.
Kick pull ratio: Trying different ratios of kick and pull, e.g., two kicks to one pull so longer period when flatter in water, feel the difference with different ratios on back.
Kick on back: Learning how to do breaststroke kick on back, with sculling arms or double arm pull (old English backstroke), feeling how this change in position affects their back. Use this position on back to improve awareness and develop breaststroke kick. Use noodle if requires support initially. Alternately stroke on front and back, if back better changing position more frequently.
Undulation: Trying breaststroke with more and less undulation. Do they feel better using more undulation to mobilise the lumbar spine or less undulation?
Underwater: Experiencing swimming breaststroke under the water, for example trying the drill; 3 kicks above water, 3 kicks below the water or breaststroke legs only under water. Being aware of feeling of weightlessness under underwater and lengthening through the trunk.
Flatter stroke: Learning a flatter breaststroke with slower stroke turnover (less ballistic), longer glide and wedge kick (the older style of swimming breaststroke). Being aware of the feeling of lengthening through trunk during glide phase.
Cool down
Stretches: Gentle stretches in the water, specific stretches advised by physiotherapist. Does the movement feel easier compared to the start of the session?
Walking in water: Walking in water and gentle movements with a fun element
Sculling and relaxation: Sculling on back with or without breaststroke kick and just kicking. Breathing, relaxation, floating on back, meditation type breathing exercises.
Easy swimming: Easy / low intensity swimming, changing the stroke from the main set, e.g., if swam on front then would cool down on back.
Session debrief
Explain how the person might **feel afterwards** and how to deal with it. Flare up of pain, advice / reassurance, and safety netting.
Cover any **teaching / coaching points** that were difficult to communicate while they were in the water or as a group. What could they adjust or adapt in the next session.
Positive feedback from teacher / coach. Finish with a reflection on achievements, not problems.
What to work on before the next session? Goals for the following week? Motivational tools they could consider? What will be covered in the next session. Dryland exercises they could try this week. Do they need any equipment next week?
Reflection on class (not shared), general feedback from swimmer. What they expected versus what they achieved during session? How it felt, was any of the session uncomfortable for their back, do they have any concerns? What went well, what did they enjoy, what was more challenging, what did they dislike? What did they find most beneficial? How are they feeling physically and psychologically? Relate to key values or goals.
Strategies to enable people with CLBP to become regular swimmers
Making swimming **fun, enjoyable, sociable**
Subsidised / discounted access to pool.

Information about access to local pools and cost. Information about changing facilities. Discuss about taking time to prepare to get in the water and to leave the venue. Information about outdoor swimming sessions with further information about safety.
Developing a **peer support group** with others in the class, using social media such as WhatsApp or Facebook.
Time to reflect on other benefits of swimming, beyond their back pain, such as improvements in fitness, general health, wellbeing, mood, general muscle strength and flexibility, and being better able to manage a healthy weight. Use these benefits as an additional motivational tool.
Encouragement and positive feedback from person leading the class, highlighting improvements since swimming. Time to reflect on benefits for back pain and general health.
Signposting to sessions for only adults and for just women or just men.
Offering a session whereby a partner, family member or friend can join them in the water.
Setting goals, being comfortable prioritizing self so able to swim regularly and making a written action plan before the last session.
Further **drop-in sessions** at pool.

The programme sections were mapped on the COM-B model, the BCW and the programme objectives; see Table 38 and Figure 22.

Table 38: Programme sections mapped onto COM-B, BCW and programme objectives

Programme section	COM-B analysis	BCW intervention functions	Objectives
Programme set up	Physical and Psychological capability; physical and social opportunity	Enablement	To integrate pain management skills with swimming
Pre-programme information	Physical and psychological capability; reflective motivation	Enablement	To integrate pain management skills with swimming To recognise and address barriers to swimming and enable people with CLBP become regular swimmers
Delivery of programme	Physical and psychological capability	Education Enablement Training	To integrate pain management skills with swimming To improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for back pain
Teaching and coaching approach	Physical and psychological capability; physical and social opportunity	Education Enablement Training	To improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for back pain
Session brief	Psychological capability and reflective motivation	Education	To integrate pain management skills with swimming

Session debrief	Physical and psychological capability; reflective motivation	Education Persuasion Training	To integrate pain management skills with swimming To recognise and address barriers to swimming and enable people with CLBP become regular swimmers
Warm up	Physical capability and psychological capability	Education Training	To integrate pain management skills with swimming
Cool down	Physical and psychological capability; social opportunity; automatic motivation	Education Training	To integrate pain management skills with swimming
Core aquatic skills	Physical and psychological capability	Education Training	To improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for back pain
Swimming strokes	Physical and psychological capability	Education Training	To improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for back pain To use swimming to improve function, physical activity, quality of life, physical and mental health, and weight management
Strategies to enable people with CLBP to become regular swimmers	Physical and psychological capability; physical and social opportunity; reflective motivation	Education Enablement Environmental restructuring Modelling Persuasion Training	To integrate pain management skills with swimming To recognise and address barriers to swimming and enable people with CLBP become regular swimmers To use swimming to improve function, physical activity, quality of life, physical and mental health, and weight management

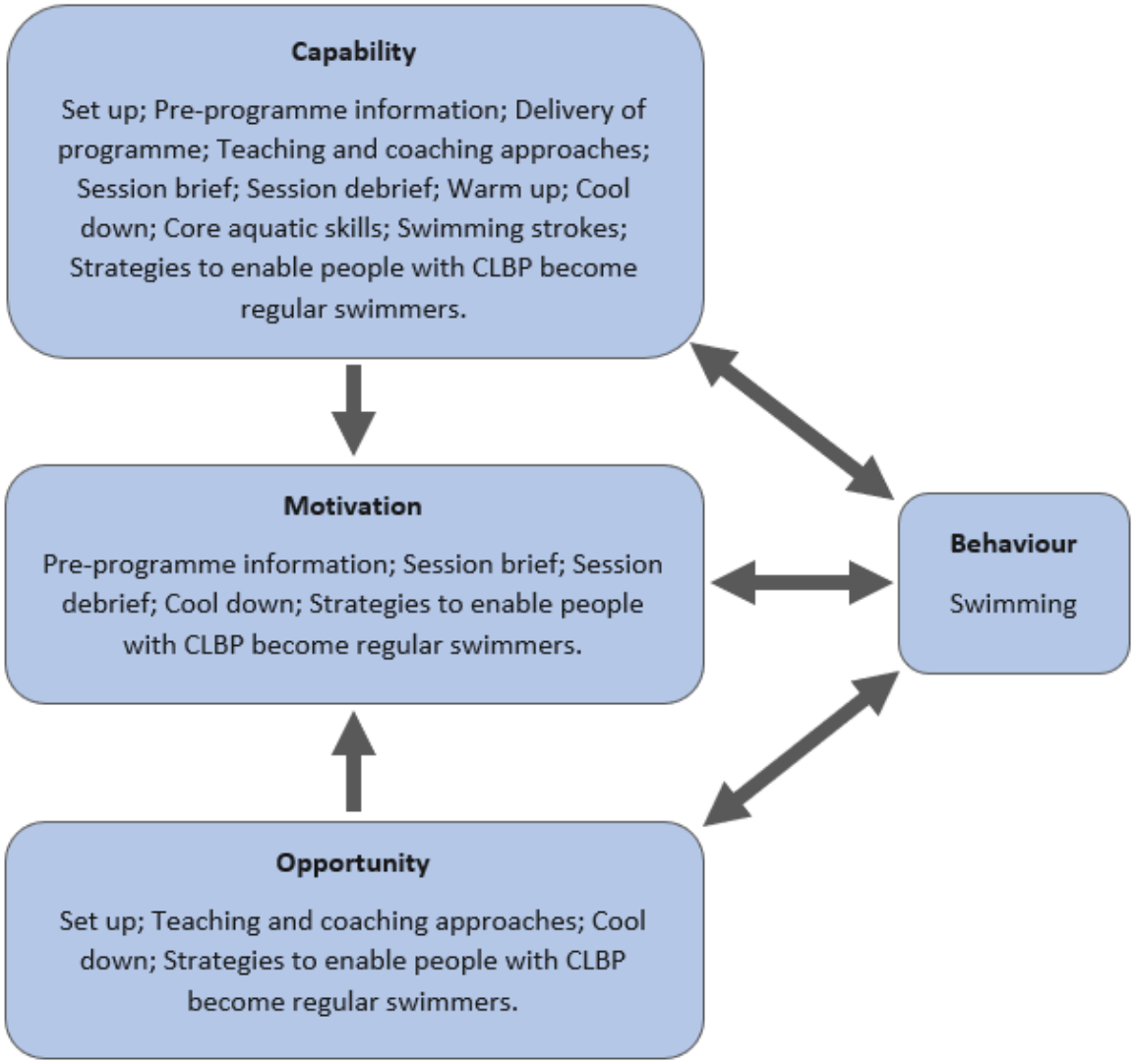

Figure 22: Programme mapped onto COM-B model

6.3 Discussion

This study, utilising a modified Delphi technique, has drawn upon the expert knowledge, skills, and experience of people with CLBP, swimming professionals, and physiotherapists to develop a swimming programme for people with CLBP. The swimming programme has not just considered the teaching of the swimming strokes, but also the programme set-up, pre-programme information, delivery of the programme, the teaching and coaching approaches, the content of the session brief, debrief, warmup and cool down, the teaching of the core aquatic skills and the strategies to enable people with CLBP to become regular swimmers. The assimilation of data from scoping review, study one and two with the data collected in the round one survey has allowed a greater range of knowledge and experience to inform the development of the swimming programme. Furthermore, the COM-B model and BCW analysis has enabled a better understanding of how the sections of the programme could impact on the behaviour of swimming and to consider interventions to target these components.

6.31 Programme Set Up

The first section of the programme aligned with the objective '*to integrate pain management skills with swimming*.' The consensus was to deliver the programme to a group of five participants; when compared to one-to-one rehabilitation there are several advantages and disadvantages to delivering rehabilitation in a group setting. It is recognised that the cost per person can be lower and the social experience of exercising within the group can result in improved levels of motivation and learning and support from peers, conversely if the group is too large it can impact learning and it is acknowledged that some people prefer to exercise alone (Barrett et al. 2018, O'Keeffe et al. 2017). In studies involving aquatic exercise the group size has been found to range from four to six (Sjogren et al. 1997), six to nine (Pires, Cruz and Caeiro 2015), and eight (Baena-Beato et al. 2014). Unlike aquatic exercise in the present study, the participants would be learning swimming skills therefore it was anticipated that it would be difficult to teach these skills to larger groups however, to make the programme cost effective the sessions could not be delivered to less than five people.

The consensus was to deliver the swimming programme once to twice a week, starting with an average of 30-minute sessions. Despite exercise being recommended as a management tool for CLBP (NICE 2016), there are currently no specific guidelines on exercise dose for this

population (Polaski et al 2019). When considering the dose of swimming for this programme, there were several considerations, including the impact on learning a new skill. To date limited research has been conducted to understand the relationship between frequency of swimming sessions and development of swimming skills. A study of children learning to swim front crawl found similar rates of improvement with 10 sessions delivered daily or on a weekly schedule (Bradley, Parker and Blansby 1996); these findings however may not be applicable to adult learners, there is currently no research to guide frequency of swimming sessions for adult learners. Another consideration was the impact of swimming dose on general health and pain; the UK's national physical activity guidelines recommend that adults accumulate at least 150 minutes of moderate intensity physical activity each week to maintain good physical and mental health (Office for Health Improvement and Disparities 2022). 150 minutes of swimming a week, however, could be too much for someone with CLBP due to movement induced pain (Polaski et al 2019).

The data from the interventional swimming studies in the scoping review found that the time in water ranged between 30-90 minutes and the frequency of the sessions ranged between one and five times a week (Ariyoshi et al. 1999; Kim, Kim, and Jung 2008; Weifen et al. 2013; Winter and McCallagy 2002). It should be noted that the 90-minute session used in the study by Ariyoshi et al. (1999) encompassed a combination of aquatic and land-based exercise and swimming and the study by Weifen et al. (2013) whereby swimming was practised five times a week recruited retired athletes. Studies involving group aquatic exercise for LBP outside the UK have been found to vary in length from 30-50 minutes (Pires, Cruz and Caeiro 2015), 50 minutes (Sjogren et al. 1997), up to 60 minutes (Abadi et al. 2019; Baena-Beato et al. 2014; Irandoust and Taheri 2015) and the frequency has been found to range from twice a week (Abadi et al. 2019; Baena-Beato et al. 2013; Pires, Cruz and Caeiro 2015; Sjogren et al. 1997) up to five times a week (Baena-Beato et al. 2014 This present study is targeted for the UK NHS population where physiotherapy provision is variable and dependent on commissioning and staffing (CSP 2012a). Nevertheless, even with constrained healthcare investment further research needs to be carried out to establish and test optimal dose of swimming for people with CLBP.

The COM-B model analysis identified that the programme set up would need to consider the physical and social opportunity and physical and psychological capability dimensions and the BCW analysis suggested that enablement should be considered for this section of the

programme to help address barriers to uptake and engagement. The data collected from all three studies also suggested that there could be many personal and external factors impacting participant engagement with the programme set up. The programme set up considered the physical opportunity by considering the time the programme was offered, the social opportunity through the provision of exercise in a group setting and the physical and psychological capability through the content of the sessions. Due to the recognition that these factors could impact the delivery of the programme; in the feasibility study the participants completed a questionnaire exploring the determinants to engagement in the swimming programme and provided feedback on the programme set up.

6.32 Pre-programme Information

The second section aligned with two objectives '*to integrate pain management skills with swimming*' and '*to recognise and address barriers to swimming and enable people with CLBP become regular swimmers*.' Before any form of rehabilitation, it is best practice to assess and screen participants, to ensure that the content of the programme is suitable for the participants and to reduce the risk of adverse effects. Consensus within the group was high regarding the pre-programme information, this was unsurprising as it has similar content to the information collected during a standard aquatic therapy physiotherapy assessment (ATACP 2021; CSP 2012b; CSP 2017) and recommended pre-course swimming screening questions (Payne 2018). The COM-B model analysis identified that the pre-programme information would need to consider the psychological and physical capability, and reflective motivation dimensions and the BCW analysis suggested that enablement should be considered to help address barriers to uptake and engagement. The pre-programme information addressed reflective motivation by asking the participants what they hoped to achieve by attending the programme, and physical and psychological capability was addressed in the content in all three questionnaires.

6.33 Delivery of Programme

This section aligned with two objectives '*to integrate pain management skills with swimming*' and '*to improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for back pain*.' Aquatic therapy is

usually delivered in a hydrotherapy pool in a hospital setting by a physiotherapist, with support from a physiotherapy technician, on discharge people with CLBP are encouraged to access community programs delivered by exercise professionals trained in delivering aquatic exercise (ATACP 2021). Other forms of community-based rehabilitation, such as cardiac rehabilitation are often delivered by both an exercise and health professional (Dalal, Doherty and Taylor 2015), the consensus in the group was for collaborative approach, whereby a physiotherapist and a swimming professional would deliver the programme. This would be a new initiative, integrating the therapeutic and educational model for delivering exercise in an aquatic environment (Dulcy 1983). It was proposed that this integrated delivery model would enable the people with CLBP in the programme to receive a high standard of swimming teaching, with specific CLBP management support from a physiotherapist. There was concern that this collaboration would increase the cost of the service, a full cost analysis, comparing the swimming programme to aquatic therapy should therefore be carried out in the future.

The survey had been distributed to both swimming teachers and coaches, most were both teachers and coaches. There is some overlap between teaching and coaching and some key differences. Novice swimmers need to be taught the strokes and core aquatic skills; this is usually delivered by a swimming teacher (Swimming.org 2022). Coaching is a two-way process, helping swimmers improve their swimming technique and fitness (Swimming.org 2022). On reflection and based upon the consensus on the teaching and coaching approaches, it might be best practice for the programme to be delivered by someone who has both coaching and teaching experience. The COM-B model analysis identified that the pre-programme information would need to consider the physical and psychological capability dimensions and the BCW analysis suggested that education, enablement, and training should be considered for this section. Using a physiotherapist and swimming professional to deliver the programme could increase the participants knowledge and skills of swimming and pain management, helping address barriers to uptake and engagement.

6.34 Teaching and Coaching Approaches

This section aligned with the objective '*to improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming*

strokes for back pain.' There are several approaches to teaching and coaching swimming; there was consensus within the group for three of the suggested approaches. The highest level of consensus within the group was for an approach that considers the different types of LBP. In the past there have been several attempts to subgroup people with LBP; one method used by physiotherapists is based upon response to movement (Karayannis, Jull and Hodges 2016). Physiotherapy research using subgrouping for CLBP has yielded mixed results; some studies found that outcomes were no different (Henry et al. 2014), other studies found superior outcomes (Long, Donelson and Fung 2004; Vibe Fersum et al. 2013). In the last few years there has been a move away from subgrouping back pain in research and clinical practice, it has been suggested that subgrouping takes a reductionist approach which does not recognise the BPS model and complexity and uniqueness of CLBP experience (O'Sullivan et al. 2018). Aggravating and easing positions for CLBP was included in the pre-programme questionnaire to enable some degree of subgrouping during the programme. It was acknowledged that recognising subgroups of people with CLBP based upon movement could still be worth exploring to enable people to learn to swim with CLBP with less post exercise soreness.

The second most popular approach within the group was an approach that aims to increase levels of physical activity, making swimming fun with less focus on swimming as a form of exercise and technique. Studies have found that people with chronic pain have lower levels of physical activity (Parker et al. 2017), which can have a negative impact on their physical and mental health leading to the development of comorbidities (Office for Health Improvement and Disparities 2022), suggesting that it would be good practice to utilise swimming as a tool to increase physical activity. However, with regards to having less focus on technique, this contrasts to recommendations from aquatic professionals (Cole 1997) and the findings from study two which suggested that developing technique made swimming more comfortable; therefore, questioning whether this was the best approach to take with this population.

The other approach which had high levels of consensus within the group were kinaesthetic problem-solving approaches. Compared to other forms of exercise such as walking or running, swimming takes place in an environment where there is much less visual and auditory sensory input and heightened kinesthesia (Shaw 2006 and Throsby 2013). Study two had highlighted that many of the participants were aware of sensations in their back whilst swimming, they spoke how they adapted their stroke or choice of stroke to reduce or eliminate the pain or

discomfort. This experience aligned with the consensus among the participants in this present study that a kinaesthetic problem-solving approach could be used in the programme. It was identified that some coaching methods also use a predominantly kinesthetic and problem-solving approach when developing swimming technique (Laughlin and Delves 2004) and that problem-solving is also used in the guided discovery approach used by Swim England (2019). Furthermore, several physiotherapy methods for people with CLBP such as cognitive functional therapy take this approach (O'Sullivan et al. 2018) and mind-body exercise programmes are recommended in the NICE (2016) guidelines. It has been suggested that swimming is not only a skill but an art, whereby the art of swimming is being able to feel effective movement and not fight the water (Lucero 2008); this is probably only possible when incorporating a kinaesthetic problem-solving approach to learning. A problem-solving approach encourages swimmers to learn through feeling and experimenting in the water (Light and Wallian 2012; Swim England 2019b).

Admittedly, problem solving is used more frequently in coaching than teaching, some swimming professionals recommend that initially with swimming people need instruction to learn skills and once they can perform the skills a more facilitative coaching approach can be taken (Payne, 2018; Swimming.org 2022). One of the swimming professionals, had also expressed concerns regarding taking a problem-solving approach until the swimmer is more confident. Within learning theories there are different views regarding the problem-solving process; behaviourists view learning as cause and effect and cognitive psychologists consider the mental process of problem solving and learning (Hardin 2003). It is likely that as swimming is a physical experience that trial and error can be used as one method of problem-solving, however as the swimmers are adults with CLBP and there is a risk of flare up of pain with too much 'error' a cognitive process could also be employed.

In swimming teaching, it is also common practice to use the part-whole or whole-part-whole method, breaking the strokes down into drills and exercises and through the aquatic skills (Brackley et al. 2020; STA 2018; Swim England 2019b). This was not discussed during this present study but could be utilized in the programme, being that it is a common teaching approach when learning new skills such as swimming. The COM-B model analysis identified that the teaching and coaching approaches would need to consider the psychological capability, physical capability, physical opportunity, and social opportunity dimensions and the

BCW analysis suggested that education and training should be considered for this section of the programme to increase the participant's knowledge and skills with regards to swimming and pain management and enablement should be considered to help address barriers to uptake and engagement; the suggested approaches align with these objectives.

6.35 Warmup and Cool Down

This section aligned with the objective '*to integrate pain management skills with swimming*.' Warmups and cool downs are recommended for both novice and competitive swimmers to get them physically and mentally prepared for swimming and enable the body to return to its resting state after swimming (Austin and Noble 1994; STA 2018; Swim England 2019b). The activities suggested in the warm-up could warm up muscles, move joints, raise heart rate, and allow the participants to adjust to the sensation and feel of the water and the feeling of weightlessness; they were also simple to perform and suitable for people with a wide range of swimming abilities. Aqua jogging was suggested for the warmup in round one by one of the people with CLBP; however, there was less than 70% consensus in the group that aqua jogging should be included; therefore, it was not included in the proposed warmup. This contrasts to recent aquatic exercise studies involving people with LBP which have included aqua jogging (Abadi et al. 2019; Carvalho et al. 2020; Irandoust and Taheri 2015). Studies investigating warmups prior to swimming have been undertaken with competitive swimmers; the results are mixed in terms of the impact on swimming performance (Neiva et al. 2014) and injury prevention (Tessaro et al. 2017), reflecting findings from a systematic review of the role of warmups and injury prevention in sport (Fradkin, Gabbe and Cameron 2006). Some studies investigating aquatic exercise for LBP have included a warmup and cool down (Baena-Beato et al. 2014; Pires, Cruz and Caeiro 2015; Sjogren et al. 1997); and one of the interventional studies in the scoping review also described similar warm up activities (Winter and McCauley-Callagy 2002). Given that the CLBP population may be physically less active and mobile it would seem wise to include a warmup and cool down. In the future it would be worth undertaking research looking into the value of warm-ups in people with conditions such as CLBP, the timing of the warmups and what should be included. The COM-B model analysis identified that the warmup and cool down would need to consider the physical and psychological capability and automatic motivation dimensions and the BCW analysis

suggested that education and training should be considered. The components in the warmup and cool down section of the programme aimed to increase the participant's knowledge and skills with regards to swimming and pain management and by incorporating a fun or relaxing element, it was anticipated that the automatic motivation dimension would also be targeted.

6.36 Core Aquatic Skills

This section aligned with two objectives '*to improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for back pain'* and *'to integrate pain management skills with swimming*.' It has been suggested that teaching the core aquatic skills can enable people to become safe and effective swimmers (STA 2018; Swim England 2019b), unsurprisingly the aquatic skills section of the survey had high levels of consensus within the group. It is recognised that less able adult swimmers may not have learned aquatic skills as a child due to lack of access to swimming lessons and changes in the way swimming was taught in the past (Button 2016). Even in children the level of aquatic skill competency is variable due to the different approaches to teaching swimming, with some approaches focusing on the traditional strokes rather than these skills (van Duijn et al 2021). Swim England (2019b) and the STA (2018) include the following activities under aquatic skills; entries, exits, floatation or buoyancy and balance, rotation, and orientation, streamlining, aquatic breathing, propulsion or travel and coordination and water safety. The participants in the survey recommended two additional core aquatic skills for people with CLBP, including coping with a painful episode when swimming, which could be included under water safety and awareness exercises. With reference to water safety, typically the focus has been how to teach children to stay safe in open water (RLSS 2021; Swim England 2019b); however, people with CLBP may have additional water safety fears or concerns. Pain-related fear is common in people with CLBP (Bunzli et al. 2017; Sieben et al 2002); the common-sense model is one framework used by physiotherapists to enable improved coping skills and to make sense of pain-related fear (Bunzli et al. 2017). With reference to the swimming programme, this could include acknowledging that the person with CLBP could experience sudden pain in the water, and the core aquatic skills to draw on could include being competent moving in all planes in the water, being able to indicate if they need help and being comfortable with aquatic breathing

(Stallman, Junge and Blixt 2008). The COM-B model analysis identified that the core aquatic skills section of the programme would need to consider the psychological and physical capability dimensions and the BCW analysis suggested that education and training should be considered. The aquatic skills included in this section of the programme would enable the participants to increase their knowledge and skills about the skills underpinning swimming.

6.37 Swimming Strokes

This section aligned with two objectives '*to improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for back pain*' and '*to use swimming to improve function, physical activity, quality of life, physical and mental health, and weight management*.' There are several approaches to teaching and coaching the swimming strokes. Some frameworks such as the STA (2018) and Swim England (2023a) focus primarily on the technical aspects of teaching swimming, coaching methods such as Total Immersion and the Shaw method recommend taking a mind-body approach (Laughlin and Delves 2004; Shaw 2006) and the Swim Smooth method considers stroke variability for people with different body types (Newsome and Young 2012). The guidance developed for the swimming strokes in this present study has considered whether any strokes should be avoided, variability in strokes and adaptive swimming, the technical aspects of the stroke, and a mind-body approach to swimming.

6.37.1 Stroke avoidance

In contrast with rehabilitation approaches based upon the fear avoidance model, whereby people are taught to recognise, confront, and manage avoidance behaviour (Bunzli et al. 2017; O'Sullivan et al. 2018) some swimming and health professionals advise that people with LBP should avoid breaststroke (Hofling et al 2002; Liyanage 2020; Young 2016). Avoidant behaviour has been linked to poor prognosis for people with CLBP in some reviews (Vlaeyen and Linton 2000), but other reviews and research found insufficient evidence that it has a negative effect (Foster et al. 2010, Pincus et al. 2002). Breaststroke is considered an easier stroke to master for adult swimmers (Liyanage 2020; Shaw 2006; Young 2016), advising against breaststroke creates barriers which may prevent a person with CLBP from trying swimming. In this present study some participants expressed concerns about including breaststroke in the programme in the first round of the survey, but during subsequent rounds

the participants moved away from recommending avoidance of breaststroke to improving technique, adapting and problem solving. It is not known whether the commonly held view that breaststroke should be avoided is based upon personal experience, theoretical assumptions or due to personal beliefs reflecting fear avoidance behaviours (Linton, Vlaeyen and Ostelo 2002). Breaststroke and butterfly are considered short-axis strokes whereas front crawl and backstroke are long axis strokes. During front crawl and backstroke the body rolls in the water through the longitudinal axis but with breaststroke and butterfly the lumbar spine flexes and extends during the stroke cycle (Miller 2015). The scoping review identified limited research to support the avoidance of breaststroke by people with CLBP (Coleman, Persyn and Winters 2000; Hofling et al 2002). It could be suggested that as there is no strong evidence to recommend avoidance of breaststroke and due to it being a common stroke used by recreational swimmers it would be worth undertaking further research in this field. The participants agreed that butterfly should initially be avoided but it could be introduced later if there was no significant aggravation. Butterfly is usually reserved for competitive swimming and is difficult to master; for these reasons it would not be included in the programme.

6.37.2 Stroke variability and adaptive swimming

Despite there being four main swimming strokes, each stroke can be swum in several ways; in competitive swimming changes to the stroke can be made to swim faster, further or to avoid injury (British Swimming 2022). Variability in strokes can be subtle, such as the amount of rotation when swimming front crawl (Newsome and Young 2012) or more pronounced, such as the differences between the older and newer forms of breaststroke (Liyanage 2020). An adapted swimming programme has been defined as one that '*modifies swim strokes for individuals who do not have the strength, flexibility or endurance to perform the standard version*' (Lepore, Gayle and Stevens, 2007, p.18). It is not known what adaptations could be helpful or beneficial for people with CLBP, however changes could be made to strokes to adapt for a lack of motor control, strength, coordination, or range of movement and to avoid positions or movements known to aggravate pain (Dunlap 2009; Liyanage 2020). Some participants were initially cautious about recommending adaptations to swimming strokes in the first round, due to lack of evidence. This cautious view was unexpected as swimming is a popular adaptive or para sport for people with a disability (ParalympicsGB 2022; Scheck and Siress 2022) enabling people to adapt their stroke within certain parameters to compete with

others (World Para Swimming 2018). It is also known that adaptive sports such as swimming can provide a bridge once people have completed their rehabilitation, helping people improve their physical fitness and quality of life (Diaz et al. 2019). Although there is some data on the number of competitive adaptive swimmers (World Para Swimming 2021), it is not known how many recreational swimmers adapt their stroke due to a long-term disability or condition, what type of adaptations are common and how they can be taught. In round two the group agreed it would be best to take a problem-solving approach to learning to swim and teaching swimmers how to adapt the stroke for nerve damage such as a foot drop; aligning with the methods described by the participants in study two.

6.37.3 Technical aspects

The front crawl section of the survey had the lowest levels of consensus in the group and the highest number of comments, this may reflect the variability in the way that front crawl is learned and swum. The body and head position during front crawl will impact on the body's movement through the water (Payne 2018, p.87; Young 2016) and the position of the spine, there is less drag when swimming when the head is in alignment with the axis of the body (Zaidi et al. 2008). There are several different head positions recommended ranging from looking down (Laughlin and Delves 2004; Liyanage 2020; Payne 2018; Smith 2014; Walker 2017), to having the water level in line with hairline (Lau and Purvis 2016; Young 2020), to having the water at the mid forehead (STA 2018; Swim England 2019b). Some manuals caution against looking directly down as this could mean that the legs would be too high in the water and the swimmer could feel unbalanced (Newsome and Young 2012). In the survey there was a high level of variability in responses regarding the suggestion in round two that the head position should be '*looking down'*, which may reflect the lack of consensus among swimming professionals on the best head position. Only one of the interventional studies in the scoping review described the teaching of the swimming strokes they used in detail (Winter and McCauley-Callagy 2002), the programme used floats, buoyancy belts and snorkels to teach a modified supine and prone swimming stroke with the aim to maintain a neutral spine position and reduce spinal rotation. It was recognised that although this could be one way to teach swimming to people with CLBP, that this approach was not in line with current management approached for CLBP (O'Sullivan et al. 2018).

6.37.4 Mind-body approach

Mind-body exercise programs such as Pilates, Yoga and Tai chi are recommended management tools for LBP (NICE 2016); incorporating awareness activities and taking a mind-body approach to teaching the core aquatic skills and swimming would align with the NICE (2016) recommendations and other popular swimming coaching methods (Laughlin and Delves 2004; Laughlin 2017; Newsome and Young 2012). Exercise is considered mind-body when it includes attention to movement and body position (Hassed 2013). When someone is learning new aquatic skills and refining and developing swimming technique, there is attention of the mind to the body; this attention can change a person's mental and emotional state which could impact on their experience of pain (Hassed 2013). Although a competent swimmer may be able to swim with little attention to the movement and their position in the water (Shaw 2006, p.30), they can still use a mind-body approach when swimming, to monitor technique and enhance performance (Laughlin and Delves 2004; Newsome and Young 2012). It is not known whether there are any additional benefits when taking a mind-body approach to swimming or when using swimming as a rehabilitation tool for CLBP.

In round two, based upon the feedback in study two and the first round of the survey, it was suggested that the swimmers could try to increase the feeling of lengthening through the spine whilst swimming with a stronger pull and not over kicking. This method of swimming could increase the drag through the legs (Sanders and McCabe 2015) whilst maintaining propulsion through the arms. Participants in study two and people with CLBP in this present study had spoken about avoiding compression and trying to enhance this feeling of lengthening through the spine when swimming. Some participants in this present study, however, had strong views regarding using language such as spine lengthening as they felt it could perpetuate unhelpful beliefs about the spine. Language is important when talking to people with LBP (Bedell et al. 2004), as negative beliefs about anatomical changes and vulnerability have been found to contribute to fear avoidance behaviour and disability (Lin et al. 2013). Swimming teachers and coaches often use verbal cues and imagery to improve and change technique and it is common practice to lengthen front crawl and backstroke by extending the arm, rotating the trunk, and developing the core muscles (Laughlin and Delves 2004; Newsome and Young 2012). Although it should be acknowledged that some language can be harmful to people with CLBP, it is important researchers and health professionals listen

to the language used by people with CLBP. If people with CLBP are using language negatively and inaccurately, for example believing that their spine is crumbling, then it would be good practice to suggest a more accurate term. However, if they are describing a sensation that feels beneficial, such as this feeling that their spine lengthens whilst swimming, maybe it is good practice to listen, and start to understand why they are feeling this way and use this effect to their advantage. The COM-B model analysis identified that the swimming stroke section of the programme would need to consider the psychological and physical capability dimensions and the BCW analysis suggested that education and training should be considered. The swimming stroke exercises and drills included in this section of the programme would enable the participants to increase their knowledge and skills about the skills underpinning the swimming strokes.

6.38 Strategies to Enable People with CLBP to Become Regular Swimmers

The final section aligned with two objectives '*to integrate pain management skills with swimming*' and '*to recognise and address barriers to swimming and enable people with CLBP become regular swimmers*.' It has been found that adherence to exercise in people with CLBP can range between 50 and 70% (Beinart et al. 2013). The BCW framework defines behavioural change interventions functions as an intervention which can change behaviour and a behavioural change technique as a '*an active component of an intervention designed to change behaviour*' (Miche, Atkins and West, 2014, p.145). The COM-B model analysis identified that strategies to enable people with CLBP to become regular swimmers would need to consider the psychological capability, physical capability, physical opportunity, social opportunity, and reflective motivation dimensions and the BCW analysis suggested that education, enablement, environmental restructuring, modelling, persuasion, and training should be considered. The strategies included in this section of the swimming programme would enable the participants to increase their knowledge and skills of using swimming as a rehabilitation modality, to use communication to induce positive feelings about swimming, to change the physical and social context when providing swimming, to provide peer support and to reduce the barriers to becoming a regular swimmer.

6.39 Strengths and Limitations

The process used to develop the swimming programme aligns with the process used by the swimming bodies in the UK (STA 2022, personal correspondence, Swim England 2023b). The process of developing a group consensus, using methods such as the Delphi technique or a focus group, assumes that judgements and guidelines developed as a group will be greater than those developed by one individual (Rowe, Wright, and Bolger 1991). Consensus, however, does not imply that the right answers have been found, with this method there is a risk of '*deriving collective ignorance rather than wisdom*' (Jones and Hunter 1995). All stakeholders were included when developing the programme and all aspects of the programme, not just the swimming strokes were considered. The three groups of experts recruited for this study had different experiences and different motivations for taking part. The physiotherapists tended to draw mainly on current rehabilitation practice and guidelines for CLBP. This meant that although their opinion was supported by current evidence, they may have had a narrower viewpoint whereby other options were not considered. Some of the swimming professionals were at times concerned that physiotherapists might encroach on their profession, a threat to their line of work; this might have led to some information not being shared. The people with CLBP were not constrained by the framework of a profession and guidelines and appeared to give more open experiential answers. Including all three groups has given a more holistic perspective but in hindsight it may have been worth increasing the number of participants in each group.

The swimming programme objectives were shared with the study participants enabling them to work towards a common objective; it is not known however whether every participant aligned their responses with these objectives. Although recruiting three distinct groups for this study had some advantages in that they had expertise in specific areas, for example teaching swimming, they may have also lacked expertise in other areas, for example pain management. It was not possible to split sections between the different experts to match their expertise due to integration of the pain management and swimming skills within sections. It could be suggested that the gaps in expertise in some areas could have impacted the responses and the development of the programme.

The study used a modified version of the Delphi method, assimilating the data from the scoping review, study one and two with the data collected in the round one survey. This

allowed a greater range of experience to inform the development of the swimming programme. The joint display tables, see Appendix G, illustrate the volume and range of data which was used to develop the swimming programme. It also highlights sections of the programme whereby there was congruence, divergence or where new insights were observed. When the data was congruent or complimentary, it could be suggested that there is increased confidence that this section of the programme is suitable for this population, whereas areas of divergence suggest that either it is a complex area or further research may be required. One drawback of the Delphi technique, as with other research methods, is participant drop off; thankfully, engagement was high. The researcher did not inquire about the reasons for drop out during the final round; it could be lack of time or disagreeing with the direction of the study findings. If this study were repeated, it would have been worth including a follow up email to participants to enquire reasons why they did not continue with the study.

6.4 Conclusions and Recommendations

This study, utilising a modified Delphi technique, has drawn upon the expert knowledge, skills, and experience of people with CLBP, swimming professionals, and physiotherapists to develop a swimming programme for people with CLBP. The swimming programme which has been developed has considered the programme set-up, pre-programme information, delivery of the programme, the teaching and coaching approaches, the content of the session brief, debrief, warmup and cool down, the teaching of the core aquatic skills and swimming strokes and the strategies to enable people with CLBP to become regular swimmers. The objectives of the swimming programme considered swimming confidence and ability, the teaching of core aquatic skills and stroke adaptations, integration of pain management skills, addressing barriers to facilitate regular swimming and using swimming to improve function, physical activity, quality of life, physical and mental health, and weight management. The assimilation of data from the scoping review, study one and two with the data collected in the round one survey enabled a wider range of knowledge and experience to inform the development of the swimming programme. Furthermore, the COM-B model and BCW analysis has enabled a better understanding of how the sections of the programme could impact on the behaviour of swimming and to consider interventions to target these components. Based on the outcomes from the feasibility study and the analysis in the meta-inference chapter the programme will be revised and refined, reflecting the process used by the UK national swimming bodies. Knowledge generation is not a static process but cyclical, particularly in the initial stages when there is little known. This swimming programme developed for people with CLBP, and the guidance developed by the national swimming bodies should be tested in trials in the future to establish the best approaches to teaching and coaching swimming to different populations.

Chapter 7:

Study Four: Swimming as a Rehabilitation Modality for People with Chronic Low Back Pain Versus Routine Physiotherapy Care: A Mixed Methods Feasibility Study

7.0 Introduction

Chapter six described the development of a swimming programme for people with CLBP using a modified version of the Delphi technique. People with CLBP, swimming professionals and physiotherapists were consulted, and the findings from the scoping review and study one and two were integrated during the development of the programme. All aspects of the swimming programme were considered including the setup, pre-programme information, delivery, teaching and coaching approach, session brief and debrief, warm up and cool down, teaching the core aquatic skills and swimming strokes and strategies to enable people with CLBP to become regular swimmers. The long-term plan is to develop and conduct a RCT to establish whether the swimming programme is equal or better than standard physiotherapy care with regards to improving pain self-efficacy, daily function, and quality of life. However, it is recommended and considered good practice that before an RCT is conducted that it is tested on a smaller scale as a feasibility study, particularly when there are several uncertainties (NIHR 2021). The difference between a feasibility study and an RCT is that a smaller sample size is recruited, there is no hypothesis, and the study is not aiming to test for efficacy (Abbott 2014). Feasibility studies can help in the development of the design of a trial and an intervention, the choice of outcome measures, determine sample size and support future funding applications (Abbott 2014). By running a feasibility study adjustments can be made to both the study design and the programme, and this can guide and assess whether it is possible to conduct a RCT (Whitehead, Sully, and Campbell 2014).

The aim of this study was to test the feasibility of the newly swimming programme as a rehabilitation modality for people with CLBP, to assess the feasibility of conducting a sufficiently powered RCT comparing the swimming programme to standard physiotherapy care and to collect data to guide refinement of the swimming programme.

7.01 Research Questions

Are the study procedures feasible for conducting a sufficiently powered RCT comparing the swimming programme to standard physiotherapy care?

Can this newly developed swimming programme be delivered as a rehabilitation modality for people with CLBP?

7.02 Study Objectives

- To assess the feasibility of conducting a sufficiently powered RCT comparing the swimming programme to standard physiotherapy care.
- To assess the feasibility of the swimming programme as a rehabilitation modality for people with CLBP.
- To collect quantitative and qualitative data to guide refinement of the swimming programme.

7.1 Methods

7.11 Study Design

A multi-methods two arm, non-randomised comparative trial design was used to assess feasibility of the swimming programme as a rehabilitation modality and trial procedures.

7.12 Participants

Patients were recruited from the physiotherapy departments at EKHUFT. The inclusion criteria for the study were that participants should have experienced CLBP for more than three months, be at least 18 years old and have a small amount of swimming experience. Exclusion criteria for the study included the following: unable to read or speak English, allergy to chlorine, severe fear of the water, pregnancy, ear infection, already a competent regular swimmer, visual impairment not correctable with glasses, medical contraindication to aquatic exercise or precaution that cannot be resolved. The following back conditions were excluded; red flag conditions (cauda equina syndrome, cancer or tumour related back pain, spinal infection, spinal cord compression, back pain from visceral source), inflammatory back pain, fractures of the spine during the last 6 months, severe spinal stenosis, nerve root compromise causing neurological deficit or constant pain in the leg, back surgery in the last 6 months, and fitted with a spinal cord stimulator. It has been suggested, based upon feasibility, precision about the mean and variance that a sample size for a pilot study should be 12 in each group (Julious, 2005) and average dropout rate is estimated to be 20.9% for exercise interventions (Kelley and Kelley, 2013). For this reason, the sample size in each group was set at 18 participants.

7.13 Study Procedures

Initially the intention was to randomise the participants but due to the limited time the pool could be hired, if the participants were available and wished to take part in the swimming arm then they were offered this intervention, if not they continued with standard physiotherapy care. Participants allocated to the swimming programme were invited to complete three short questionnaires to assess general health, back pain, and swimming ability and experience, see

Appendix H, I and J. Both the swimming and physiotherapy groups completed the three outcome measures, the Oswestry low back pain disability index (ODI), the pain self-efficacy questionnaire (PSEQ), and the EQ-5D-3L, before the intervention, after the last appointment and 6 months later, see Appendix K, L, and M. Data was collected to report participant characteristics: including age, gender, and length of time with LBP. A follow up participant feedback questionnaire was also distributed to the participants in the swimming arm on completion of the programme and 6 months later, see Appendix N and O.

The participants in the physiotherapy arm attended the physiotherapy department in the hospital. Treatment delivered by the physiotherapist could include exercise, advice, education, and manual therapy; they were offered up to 6 sessions. Some appointments were delivered in a cubicle and others in the physiotherapy gym. The time between appointments varied from person to person.

The six swimming sessions were delivered twice a week over three weeks in a hotel leisure centre pool on a Wednesday morning and a Friday afternoon. The water was kept at 29°C but for some sessions it dropped to 27°C due to issues with the boiler. The dimensions of the pool were 5m by 15m and the depth varied from 0.75m to 1.5m. The pool access was via steps with a rail or a ladder. The swimming session lasted between 30 and 60 minutes, the time was built up gradually as the sessions progressed, there were up to 5 participants in the sessions. The sessions were led by a Level 2 swimming teacher and the researcher. The researcher is an advanced practice spinal physiotherapist and Level 2 swimming coach, for the purpose of this study she was able to advise on the research study, swimming coaching and answer questions relating to CLBP. Most sessions were delivered with the swimming teacher and researcher in the water. A session plan was followed, which included aims, objectives, learning outcomes and suggested core aquatic skills and swimming activities under each section. The session consisted of a session brief, a warmup, core aquatic skills, swimming strokes (front crawl, backstroke, breaststroke, and hybrid strokes), a cool down and a session debrief; following the guidance developed in study three. The session plans were reviewed by two level two swimming teachers prior to delivery, see Appendix P. Observational field notes were made on the swimmer's progress on the session plan after each session by the swimming teacher and the researcher.

The objectives of the swimming programme were as follows:

- To improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for back pain
- To integrate pain management skills with swimming
- To recognise and address barriers to swimming and enable people with CLBP become regular swimmers
- To use swimming to improve function, physical activity, quality of life, physical and mental health, and weight management

7.14 Data Collection Tools and Analysis

Data concerning the feasibility of the study procedures, including the recruitment rate, recruitment time, availability, equity to access to treatment in the comparison group, retention rates, incomplete data and safety data was collected through administrative data by the researcher and recorded in the research files. The study assessed the recruitment and retention rate in order to understand the estimated time period it would take to recruit the required number to an RCT at one site. The data would inform whether the project was feasible to run as an RCT and whether other sites would be required to meet timelines for grant applications. It was estimated based upon waiting list data that within the catchment area of the project that on average 30 patients a week were seen in outpatient clinics with CLBP. A power calculation estimated that if an RCT was undertaken, using the same process used in this feasibility study, that 180 patients would need to be recruited and randomly assigned to the swimming programme or standard physiotherapy care (n=90 each group.) This calculation was based on the minimal clinically important change estimates of 5.5 for the PSEQ 5.5 (Chiarotto et al. 2016) on a scale from 0-60 with 60 being higher self-efficacy beliefs and a standard deviation of 13.4. The numbers were calculated using a 5% significance level, 80% power and taking into account a 10% drop out rate. The retention data was used to inform whether the estimated 10% drop out rate used within the power calculation was accurate or would need to be adjusted. This data was analysed using descriptive statistics; see Table 39.

Quantitative and qualitative data was collected at baseline, on completion of the programme and 6-months later to assess the feasibility of the swimming programme as a rehabilitation

modality for people with CLBP and to guide refinement of the swimming programme in the mate inference chapter. Data was collected using questionnaires and through observational field notes made on the session plans by the swimming teacher and researcher. There were eight questionnaires including three pre-programme questionnaires, three validated outcome measure questionnaires, and two post-programme feedback questionnaires. The participants also completed the following three outcome questionnaires: the ODI, PSEQ, and EQ-5D-3L, before the intervention, after the last appointment and 6 months later, see Appendix K, L, M. The PSEQ is composed of 10 questions scored on a Likert scale asking the participant how confident they are to do an activity despite the pain; it is reported to have high internal consistency, reliability, and validity (Nicholas 2007). The ODI (version 2.0) measures function and disability (Fairbank *et al*. 1980; Fairbank and Pynsent 2000.) This questionnaire is composed of 10 questions with 6 response statements and has been found to have acceptable internal consistency and moderate correlation with other measures of pain (Fairbank and Pynsent 2000). The EQ-5D-3L measured health related quality of life, this outcome measure is recommended by NICE over the EQ-5D-5L (NICE 2018). The EQ-5D-3L is composed of 5 quality of life questions with 3 levels of response and a 6th question which is scored on a 100-point scale regarding health state (EQ-5D 2015).

The quantitative data was analysed with descriptive statistics and the qualitative data using thematic analysis, using the same process as in study two. The data from the ODI, PSEQ and EQ-5D-3L was analysed with descriptive statistics and only reporting within group effects, due to the study being underpowered, see Table 40.

Table 39: Data collection and analysis to assess the feasibility of the study procedures

Domain	Data collection	Data analysis
Recruitment rate	Number of patients invited to take part eligible to take part in the study versus how many consented to take part.	Descriptive statistics as a percentage of those who were invited and those who consented.
Recruitment time	Number of weeks taken to recruit the required number of participants.	Descriptive statistics in weeks.
Participant availability for swimming programme	Number of participants who could not take part due to the availability of pool time.	Descriptive statistics as a percentage who were available for the swimming sessions.
Equity to access to treatment in the comparison arm following consent to study	Waiting times were recorded for the swimming group and standard physiotherapy care group following consent to study.	Descriptive statistics, calculating the median and range of waiting times
Retention rates in swimming arm	Retention rates of participants in the trial was evaluated by recording how many swimming sessions were missed by the participants, and what percentage of participants missed more than four out of six sessions.	Descriptive statistics as a percentage.
Incomplete data in swimming arm	The outcome questionnaires were checked for incomplete data and the number of questionnaires which were not returned was also recorded.	Descriptive statistics as a percentage.
Safety data in swimming arm	The safety of the swimming programme was evaluated by recording the number of adverse events directly relating to the swimming programme, the number of sessions provided and the number of participants in each session.	Details of adverse reactions were collated. The number of adverse reactions was divided by the total number of sessions provided per person, reported as a percentage.

Table 40: Data collection and analysis to assess the feasibility of the swimming programme as a rehabilitation modality

Objective	Data collection	Data analysis
To improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for back pain	Ability: Pre-programme questionnaire, observational data recorded on session plan and post-programme questionnaire. Data was collected about the participant's perception of their swimming ability at baseline via a questionnaire. The data reported on completion of the programme was the swimming teacher and researcher's assessment of the participant's swimming ability and which learning outcomes had been achieved. The participants were asked about swimming ability 6 months after the programme in the follow up questionnaire. Adapting: Observational field notes recorded on session plan and post-programme questionnaire about adapting swimming for CLBP. Confidence: Post programme questionnaires and observational data.	Thematic analysis and descriptive statistics, percentages, median and range.
To integrate pain management skills with swimming	Observational data recorded on session plan and feedback from post-programme questionnaire	Thematic analysis
To recognise and address barriers to swimming and enable people with CLBP to enable people with CLBP become regular swimmers	Post-programme questionnaire (open and closed responses)	Thematic analysis and descriptive statistics, percentages.
To use swimming to improve function, physical activity, quality of life, physical and mental health, and weight management	ODI (version 2.0) (Fairbank *et al*. 1980; Fairbank and Pynsent 2000), PSEQ (Nicholas 2007); and the EQ-5D-3L (EQ-5D 2015); participant feedback questionnaire (open and closed responses).	Thematic analysis and descriptive statistics, percentages, median and range

7.2 Results

7.21 Participant Characteristics

Participant characteristics are reported in Table 41.

Table 41: Participant characteristics study four

Participant characteristics	**Swimming arm (n=22)**	**Physiotherapy arm (n=10)**
Age in years, median, range	56, 27-72	40.5, 29-59
Females % (n)	72.7(16)	70(7)
Ethnic group white % (n)	86.4(19)	100(10)
Number of years with LBP, median, range	7, 0.5-52	Not collected
BMI, median, range	28.5, 17.3-58.7	Not collected

7.22 Feasibility of Study Procedures

Figure 23 reports the numbers of participants approached for the study, enrolled in each arm, the number who completed the study, completed the 6-month follow up and the numbers lost to follow up. Table 42 reports the results, context, and recommendations for future studies for the data pertaining to the feasibility of the study procedures.

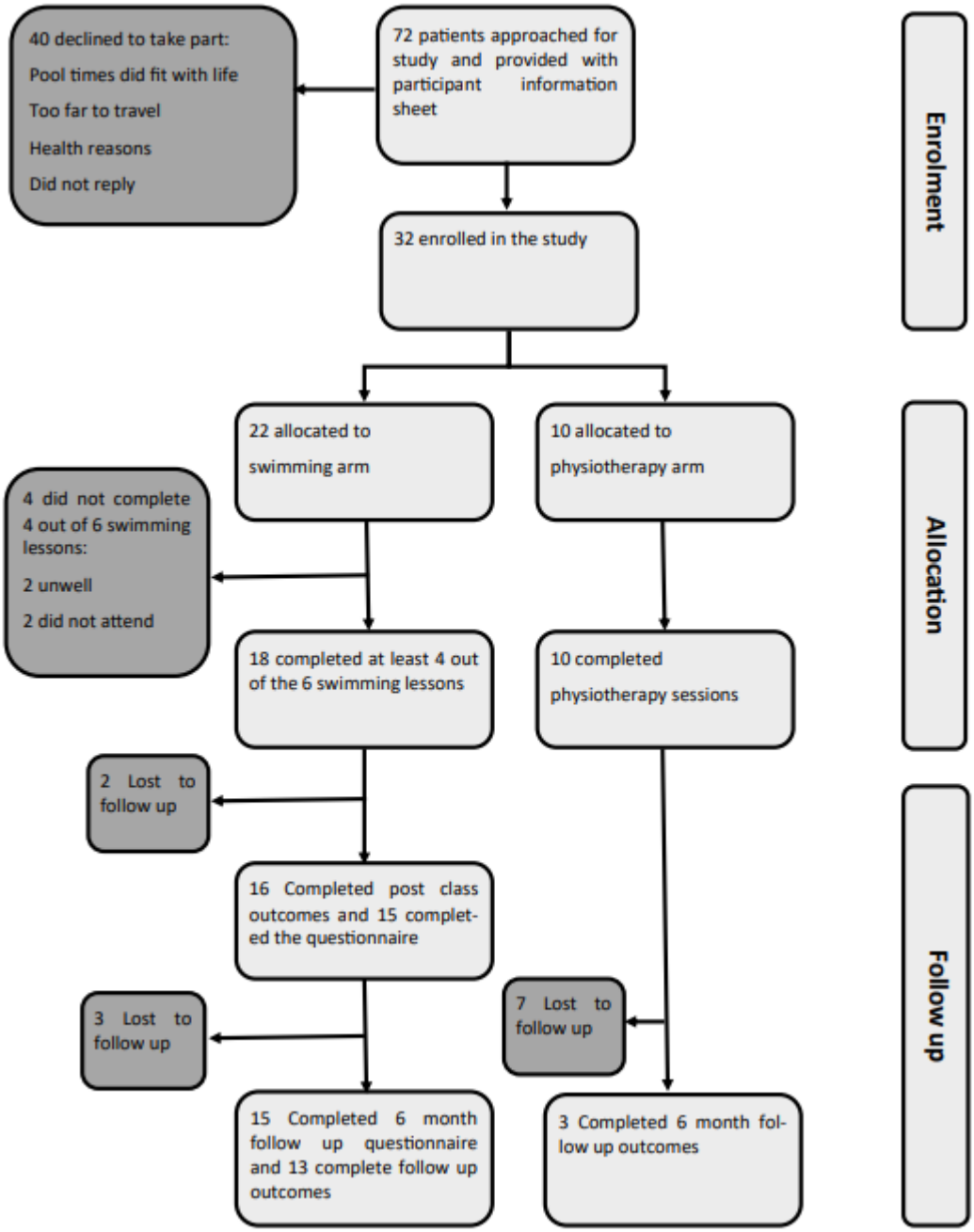

Figure 23: Participant flow diagram

Table 42: Results, context, and recommendations for the data pertaining to the feasibility of the study procedures

Domain	Results	Context	Recommendations for future studies
Recruitment rate	72 patients were invited to take part in the study, of which 32 were enrolled in the study. The recruitment rate calculated that 44.4% of people invited to read about the study consented to take part.	Patients were not invited to take part if they did not meet the inclusion / exclusion criteria.	Additional sites and clinics with a greater number of people with CLBP would be required to improve the feasibility of running an RCT.
Recruitment time	It took 23 weeks to recruit 32 participants for the study, 1.39 patients per week. At this rate it would take 129 weeks to recruit 180 patients for an RCT	The COVID-19 pandemic may have impacted recruitment rate and the coastal location of the pool reduced catchment radius.	Additional sites and clinics with a greater number of people with CLBP would be required to improve the feasibility of running an RCT.
Participant availability for swimming programme	29 people were interested in taking part in the swimming programme, however only 76% (n=22) could take part based upon the times offered. Reasons for not being able to make the pool times included work and childcare responsibilities.	It was difficult to find pool hire for the period of the study and to find times that suited the availability of the researcher and swimming teacher.	A greater range of pool times would be required to enable randomisation in an RCT.
Equity to access to treatment in the comparison arm following consent to study	The median time people waited in the swimming arm for their first session was 8.5 days (range 1 to 24 days) compared to 54.5 days (range 1 to 100 days) in the standard physiotherapy care arm.	The people receiving standard physiotherapy care had to wait for a longer period before receiving treatment and had longer gaps between appointments due to staff sickness due to COVID-19. Due to these difficulties with the comparison group the number enrolled was less than the swimming arm.	A group exercise treatment delivered as the standard physiotherapy care, funded by the study would enable equity to access to treatment in the comparison arm.

Retention rates in swimming arm	41% (n=9) of participants attended all 6 sessions, 41% (n=9) of participants attended 4-5 sessions and 18% (n=4) of participants attended less than 4 sessions. The participants had been advised that they should try and attend at least 4 out of 6 sessions; 73% (n=16) of participants in the swimming arm met this target.	Reasons for not attending a session ranged from ill health, childcare, attending another appointment, holiday, and difficulty getting to the pool due to transport issues. The COVID-19 pandemic appeared to have a negative impact on retention rates.	Strategies to improve retention rates in both arms should be explored through stakeholder consultation.
Incomplete outcome data in swimming arm	69% (n=11) of participants returned their outcome measures at 6-months.	Participants were sometimes slow completing questionnaires and 53% (n=8) needed reminding. It is not known why some participants only returned their feedback questionnaires.	Outcome measures and feedback data could be completed at the pool after the last session. Participants may need to be invited to return for a follow up appointment at 6-months to complete the outcome forms and surveys
Incomplete participant feedback data in swimming arm	94% (n=15) of participants in the swimming arm returned their feedback questionnaires at 6 months and The benchmark was set at less than 15% missing outcome measures and questionnaires; therefore, only the feedback questionnaire met the benchmark,		
Safety data in swimming arm	There was two minor adverse reaction during the study. The first related to a set of goggles not fitting correctly, this problem resolved within ½ hour, and a larger set of goggles was provided. The other was that a participant developed a mild chlorine allergy resulting in mild cold symptoms after the session.	24 group sessions of swimming were delivered during the study, the group size was a maximum of 5 participants and the range of numbers of sessions was 1 to 6. The total number of sessions delivered was calculated to be 101. The adverse reaction rate over the course of the study was calculated to be 2%. See Table 42 for incidents and adverse reactions during study.	The programme had a low risk for adverse reactions, future trials should continue to collect safety data. The issue with goggles reinforced the importance of ensuring that they are able to fit their goggles correctly during the first session and having a range in sizes and styles. It is well known that some swimmers can develop a mild chlorine allergy, this can often be mitigated by wearing a nose clip.

7.23 Safety Data

Table 43 documents the incidents and adverse reactions recorded during study.

Table 43: Incidents and adverse reactions during the study

Participant no.	Incident	Related to programme?	Outcome
3a	Developed a cold	No	Missed 2 sessions
7a	Slipped previous day to class	No	Check up with GP before session
7a	Reaction to COVID-19 booster injection	No	Unwell, in bed for 2 days
5a	Flare up of sciatica	No	Patient felt sciatica flare up unrelated to session
6a	Had to isolate due to COVID-19	No	Missed 2 session
8a	Hypertension	No	Under GP hypertensive medication reviewed
9a	Reaction to COVID-19 booster injection	No	Missed 1 session as arm swelled and felt unwell
9a	Developed a head cold	No	Missed 1 session
9a	Developed a mild chlorine allergy (cold symptoms)	Yes	Participant decided not to continue with swimming on completion of the programme, he did not wish to try a nose clip
14a	Black line in vision after wearing goggles during first class	Yes	Provided with larger set of goggles. Black line faded after 1/2 hour
17a	Sudden onset of pericarditis	No	Missed last 3 session, put on 3 months course of colchicine

7.24 Feasibility of Swimming Programme as Rehabilitation Modality for People with CLBP and Data to Guide Refinement of the Swimming Programme

7.24.1 Results mapped alongside the swimming programme objectives

Table 44 reports the quantitative and qualitative data collected during the study, the context and recommendations for future studies mapped alongside the swimming programme objectives.

Table 44: Study findings mapped alongside the swimming programme objectives

Results	**Context**	**Recommendations for future studies**
Objective 1: To improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for back pain		
Swimming ability: Prior to starting the programme 31% of participants were able to swim a length of the pool and on completion of the programme 75% were able to swim that distance. See Table 44 for development of swimming ability and skills during the study period	Over the 6 sessions only 2 swimmers did not achieve all learning outcomes, they were more nervous swimmers. On completion of the programme, they signed up for private lessons to continue to develop their swimming ability.	The number of sessions may need to be increased for more nervous swimmers; in the current form it enabled the development of swimming ability for the majority of participants.
Adapting swimming: Under the theme, *delivery of the programme*, subtheme, *problem solving and adapting swimming*, various strategies were mentioned in how problem solving was used to adapt swimming for CLBP	Adaptations were documented in the observational notes and the participant feedback questionnaire.	Further research would be required to better understand and document these adaptations.

Confidence: Under the theme, *therapeutic effects,* subtheme, *confidence*, the participants spoke about gaining or regaining confidence through the swimming programme	Discussion and notes about confidence was documented in the observational notes and the participant feedback questionnaire.	Further research would be required to develop a better understanding of how to facilitate confidence in this population.
Objective 2: To integrate pain management skills with swimming		
There are a wide range of pain management skills, the theme, *enablers*, included *goal setting, prioritising, building a support team, and developing exercise routine*	Discussion and notes about pain management skills was documented in the observational notes and the participant feedback questionnaire.	Further research would be required to understand which pain management skills could be of value when delivering swimming as a rehabilitation modality
Objective 3: To recognise and address barriers to swimming and enable people with CLBP become regular swimmers		
Barriers: After the programme the participants were asked about barriers which might stop them swimming, these were the same barriers included in the survey in study 1. The top barriers were cost (67%, n=10), time (60%, n=9), pool temperature (53%, n=8), swimming ability (40%, n=6), pain after swimming (40%, n=6), and lack of motivation (40%, n=6). The theme, *barriers* identified ten barriers: *time, cost, caring responsibilities and work, co-morbidities, pool temperature, lack of confidence, mental health, loss of sensation, and short-term illness*	Data was only collected regarding barriers, not how to address barriers	The thematic analysis identified additional barriers not asked in the questionnaire. Further research on barriers and enablers is required to better understand how barriers can be addressed.
Regular swimmers: Prior to the swimming programme only 6% (n=1) of the participants had swum regularly and most hadn't swum for many years. After the programme all but one of the participants intended to go swimming, that participant was not intending on swimming due	Participant numbers are low so limited conclusions can be drawn	Refinement of the programme may be required to enable people more people develop into regular swimmers.

to a chlorine allergy which affected his nose. The 6-month follow up questionnaire found that 60% (n=9) had continued swimming on a regularly basis.		
Objective 4: To use swimming to improve function, physical activity, quality of life, physical and mental health, and weight management		
Physical activity: 60% of participants were still swimming 6-months after completing the programme.	Participants were also asked whether since the programme they had taken up any other form of exercise. Participants reported that they were now walking (n=5), cycling (n=2), attending an exercise class (n=1) and walking netball (n=1) since completing the class. Only 20% (n=3) were not swimming or doing another form of exercise at 6 months.	Further research would be required to better understand the value of being more physically active with swimming. It is not known whether improved levels of physical activity impacted the management of CLBP
Function and quality of life: See Table 45 for full results from PSEQ, ODI and EQ-5D-3L. The data was underpowered so was only presented with descriptive statistics, the data shows small improvement in disability and quality of life within the groups.	The baseline scores were higher for the swimming arm showed more severe disability and lower levels of pain self-efficacy than the physiotherapy arm. There was very little data collected in the physiotherapy arm.	Randomisation may need to consider matching the groups for baseline characteristics. No conclusions can be drawn from this data as it is under powered.
Physical health: The median health status score for the EQ-5D-3L improved by 10 points in the swimming arm and 15 points in the physiotherapy arm	There was very little data collected in the physiotherapy arm.	No conclusions can be drawn from this data as it is under powered.
Mental health: There was no change in the level 1 scores for mental health The theme *therapeutic effects*, subtheme *mental health, and wellbeing*, discussed improvement in mental and health and wellbeing during the programme. The theme, *barriers*, subtheme	The mental health domain is brief in the EQ-5D-3L	A different mental health outcome measure could be considered in future studies

mental health discussed how anxiety can be a barrier to swimming.		
Weight management: The programme was accessible to people with a wide range of BMIs; ranging from 17.3 to 58.7, median 28.5. 4 participants were obese, and 2 participants were severely obese, 2 participants were underweight. No data was collected regarding change in BMI.	Data was not collected regarding change in BMI to reduce participant burden	Future studies could collect post-programme BMI data

7.24.2 Swimming ability data

The participants were asked to rate their swimming ability at baseline via the pre-programme questionnaire, the swimming teacher and researcher assessed the participant's swimming ability and which learning outcomes had been achieved on completion of the programme and the participants were also asked about swimming ability at 6-months; see Table 45

Table 45: Swimming ability

	Baseline (n=16)	**On completion (n=16)**	**6-months (n=15)**
% (n)	**Yes**	**Yes**	**Yes**
Able to swim 1 length	31(5)	75(12)	73(11)
Able to swim front crawl	44(7)	88(14)	87(13)
Able to swim backstroke	63(10)	94(15)	67(10)
Able to swim breaststroke	75(12)	94(15)	87(13)
Comfortable in deep water	38(6)	94(15)	
Able to put face in water	56(9)	100(16)	
Uses goggles to swim	38(6)	100(16)	
Achieved all learning outcomes		88(14)	

7.24.3 Outcome measure data

Participants completed the PSEQ, ODI and EQ-5D-3L at baseline, on completion of the programme and 6-months later; see Table 45. Minimal clinical differences (MCD) vary depending on the method of assessment, there is currently no single agreed score (Schwind et al. 2013); the range of MCD has been cited at the bottom of Table 46. The baseline scores were higher for the swimming arm than the physiotherapy arm and the data was underpowered so is presented with descriptive statistics. The data shows small within group improvements in pain self-efficacy, disability, and quality of life for the swimming group and larger improvements in the physiotherapy arm. No conclusions can be drawn due to the difference in baseline scores and the low number of outcome measures completed in the physiotherapy arm.

Table 46: Outcome measures at baseline and 6-months

	Swimming arm			Physiotherapy arm		
Scale	**Baseline**	**6-months**	**Difference in median score**	**Baseline**	**6-months**	**Difference in median score**
PSEQ (median, range)	23.5, 0-50 (n=18)	25, 15-51 (n=13)	1.5	26.5, 11-51 (n=10)	49, 40-60 (n=3)	22.5
ODI (median, range)	49, 18-86 (n=18) Severe disability	38, 18-72 (n=13) Severe disability	11	35, 14-68 (n=10) Moderate disability	20, 2-22 (n=3) Minimal disability	15
EQ-5D-3L n (%)	**n=17**	**(n=13)**	**Difference**	**(n=10)**	**(n=3)**	**Difference**
Mobility Level 1=	1 (5.9)	3 (23.1)	+17.2%	4 (40)	3 (100)	+60%
Level 2=	16 (94.1)	10 (76.9)	-17.2%	6 (60)	0 (0)	-60%
Level 3=	0 (0)	0 (0)	0	0 (0)	0 (0)	0
Self-care Level 1=	8 (47.1)	7 (53.8)	+6.7%	6 (60)	3 (100)	+40%
Level 2=	9 (52.9)	6 (46.2)	-6.7%	4 (40)	0 (0)	-40%
Level 3=	0 (0)	0 (0)	0	0 (0)	0 (0)	0
Usual activities Level 1=	0 (0)	0 (0)	0	2 (20)	1 (33.3)	+13.3%
Level 2=	15 (88.2)	12 (92.3)	+4.1%	7 (70)	2 (66.7)	-3.3%
Level 3=	2 (11.8)	1 (7.7)	-4.1%	1 (10)	0 (0)	-10%
Pain / discomfort Level 1=	0 (0)	0 (0)	0	0 (0)	0 (0)	0
Level 2=	11 (64.7)	9 (69.2)	+4.5%	8 (80)	3 (100)	+20%
Level 3=	6 (35.3)	4 (30.8)	-4.5%	2 (20)	0 (0)	-20%
Anxiety / depression Level 1=	4 (23.5)	3 (23.1)	-0.4%	4 (40)	1 (33.3)	-6.7%
Level 2=	10 (58.8)	8 (61.5)	+2.7%	4 (40)	2 (66.7)	+26.7%
Level 3=	3 (17.6)	2 (15.4)	-2.2%	2 (20)	0 (0)	-20%
Health status Median, range	40, 10-70	50, 0-80	+10 (median)	55, 10-90	70, 70-80	+15 (median)

PSEQ; 0 = not at all confident, 60 =completely confident; Minimal clinical difference range 5.5-8.5 (Dube, Langevin and Roy 2021); 8.5 (Maughan and Lewis 2010); 5.5 (Chiarotto et al. 2016). ODI; 0 = minimal disability, 60= maximum disability; minimal clinical difference 7.5 for the ODI (Maughan and Lewis 2010). EQ-5D; Level 1 indicates no problems, Level 2 some problems and Level 3 extreme problems; 100=the best health you can imagine, 0=the worst health you can imagine

7.24.4 Qualitative data

Five themes were developed using thematic analysis of the combined qualitative data from the feedback questionnaires and from the observational data recorded on the session plan by the swimming teacher and physiotherapist. The five themes were: *'Delivery of programme'*, '*Therapeutic effects', 'Short-term side effects', 'Barriers', and 'Enablers';* see Table 47 for summary of themes and subthemes and Figure 24 for the thematic map.

Table 47: Themes and subthemes for observational and participant feedback data

Themes				
Delivery of programme	Therapeutic effects	Short-term side effects	Barriers	Enablers
Subthemes				
Set up of programme	Pain relief	Pain	Time and cost	Motivation and goal setting
Professional support	Flexibility	Fatigue	Caring responsibilities and work	Support after programme
Peer support	Mental health and wellbeing	Minor adverse reaction	Co-morbidities	Exercise routine
Heterogeneity	Enjoyment		Pool temperature	Access to swimming
Aquatic skills	More able in the water		Lack of confidence	
Swimming skills	Confidence		Mental health	
Problem solving and adapting swimming	Achievement		Loss of sensation	
Equipment	New purpose		Short-term illness	

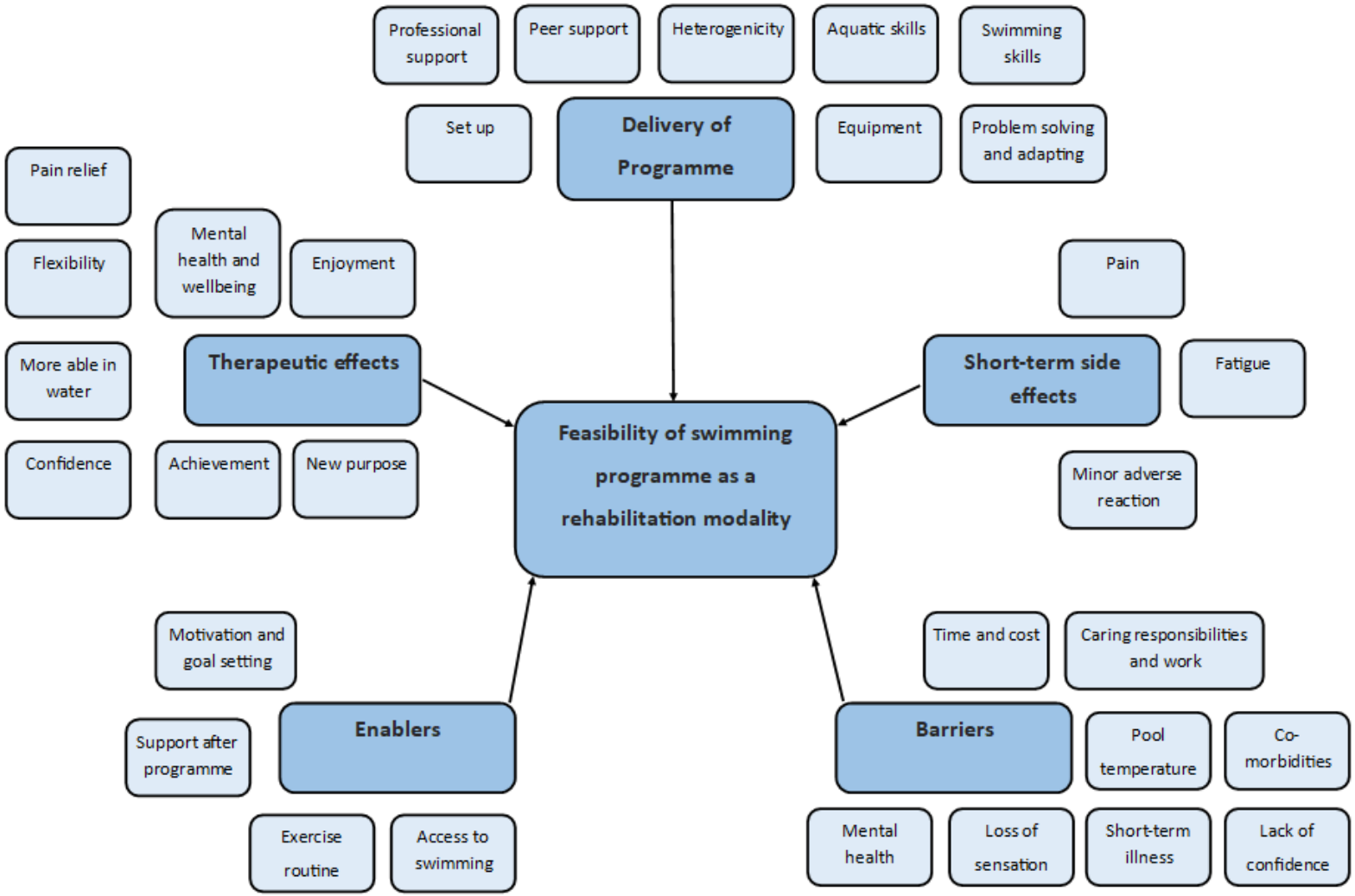

Figure 24: Thematic map: Feasibility of swimming programme as a rehabilitation modality

Theme 1: Delivery of programme

Theme one included eight subthemes describing different aspects of the delivery of the swimming programme; see Table 48.

Table 48: Theme one: Delivery of programme

Theme 1	**Description**		
Delivery of programme	Different aspects of the delivery of the swimming programme		
Subtheme	**Description**	**Participant data**	**Observational data**
Set up of programme	Set up of programme including length and frequency of the sessions	*'When we overran, I started to feel the pain'* *'Additional lessons would have benefitted me more I believe'*	
Professional support	Professional support from the physiotherapist and / or swimming teacher and the need for long term support	*'Both of the tutors were understanding of individuals needs and gave reassurance where necessary (S4)'* *'The swimming was enjoyable for the period I did it, but I think that I need more long form therapy as the problem is ongoing. (S20)'*	*Enjoying class. Will book more lessons with local teacher at pool, whom she knows, to gain more confidence and control in the water (S13)*
Peer support	Peer support within the swimming programme	*'I spend more time interacting with fellow swimmers, time for a chat; I always go with one of the other ladies from the class (S19)'* *Both (S15) and (S11) have encouraged each other with their swimming, and both realise the benefits to help alleviate their back problems. They are both confident and safe swimmers now. The group are very supportive of each other and that has really helped. Everyone was impressed with (S11)'s front crawl today and she really does look like a swimmer. During the last session (S10), (S8) and (S9) exchanged numbers to support each other.*	*Both (S15) and (S11) have encouraged each other with their swimming, and both realise the benefits to help alleviate their back problems. They are both confident and safe swimmers now. The group are very supportive of each other and that has really helped. Everyone was impressed with (S11)'s front crawl today and she really does look like a swimmer. During the last session (S10), (S8) and (S9) exchanged numbers to support each other.*

Heterogeneity	Participants had different levels of confidence in the pool and ability to swim, each person's journey through the swimming programme was individual	*'Although 6 lessons is adequate for people with back pain, for those who struggle with lack of confidence progress is slower' (S4)* *'The people were of varying abilities, so the physiotherapist and swimming teacher were busy all the time' (S12)*	*We walked around the edge of the pool and could see who was nervous and unsteady in the water, who needed more supervision.* *(S2) continued to work on slowing her stroke down and breathing at the correct point and (S5) was OK with front crawl this week but prefers back stroke. (S2) legs sink and she preferred the fins and (S5) preferred the hand paddles.*
Aquatic skills	Examples of core aquatic skills they found helpful in the programme	*'I could not balance, even in water to start with' (S13)*	*They hadn't tried gliding before; they were surprised that they could travel the whole width without kicking. They found gliding on their side harder to master but easier on their back.*
Swimming skills	Examples of swimming skills they found helpful in the programme	*'Previously I had only managed breaststroke but this is not suitable for me at this time in my recovery so I felt I received great tuition on learning a way I could do front crawl and back stroke' (S10)*	*(S6) said she was 'rubbish' at front crawl because she kept her head up so we progressed from a push glide with her face in the water and she attempted to breath to the side*
Problem solving and adapting swimming	Problem solving how to use swimming more effectively to manage CLBP and being able to adapt swimming for CLBP	*'I use a "noodle" to support my shoulder and to align my body, I find it beneficial' (S19)'.*	*(S12) had to bend her knees and was able to problem solve how she could float.* *(S14) has a painful right shoulder with limited movement, so we taught her under water recovery stroke with less rotation of body* *(S18) was keen to learn what she could as this was her last session. We focused on problem solving how to make swimming comfortable for her back. I asked her whether she had any back pain in a simple glide with*

			kick, she did not. Her body position looked good.
Equipment	The use of equipment to enable swimming		*(S14) felt more confident wearing a nose clip with her breathing, she didn't think she would have progressed so quickly without.*

Theme 2: Therapeutic effects

Theme two included eight subthemes describing the therapeutic effects during and after swimming; see Table 49.

Table 49: Theme two: Therapeutic effects

Theme 2	**Description**		
Therapeutic effects	Therapeutic effects during and after swimming		
Subtheme	**Description**	**Participant data**	**Observational data**
Pain relief	Reduction in pain levels during or after swimming	*'The weightless feeling the water gave me the best relief I've had since my injury. (S17)'*	*All three agreed that front crawl and backstroke caused no pain, and they could feel the benefits, but they all felt that breaststroke could aggravate hip and knee joint problems.*
Flexibility	Improvement in flexibility	*'I continue to swim to try and reduce pain and to keep myself as flexible as possible (S18)'*	
Mental health and wellbeing	Improvement in mental health and wellbeing	*'I feel this course has really benefitted me. Both mentally and physically it has had a positive effect (S10)'* *'I felt more alert. Everyone I saw after the lessons said how well, I looked. (S13)'*	*(S12) Reported two positive effects she is feeling more relaxed, her husband is unwell, she is also sleeping better.*
Enjoyment	Swimming being an enjoyable activity	*'Sea swimming on holiday for enjoyment (S1)'*	*We finished with diving to pick up sinkers, everyone smiled and relaxed during this activity.*
More able in water	Able to do more in the pool than on land	*'100% was able to do more in the water than out. I wouldn't be able to do the same level of exercise out of a swimming pool. (S17)'*	

Confidence	Gaining or regaining confidence through the swimming programme	*'I really enjoyed my sessions and feel that I have become more confident in the water (S11)'. 'I'm very grateful for the confidence it's given me to get back in the water as prior to my back injury I was quite active to what I am now (S17)'* *'The swimming class helped me gain my confidence and I did not panic too much. Thank you. (S9)'*	*(S9) is more confident and happier with all 3 strokes and will try to use them on her cruise. She needs to believe in herself. (S21) is able to manage a length and we can see how much more confident he is in the water; he is now able to plant feet easily on floor whereby he struggled with this skill at his first session. (S3) had definitely made the most improvement and altogether seemed happier and more confident.*
Achievement	Proud of achievements during swimming programme		*(S14) spoke about how the class had made her leave the house and catch a train, her adult children were proud of her, and she had started to consider local pools she could go to. (S4) was very pleased with herself and admitted that she had never really ever swum properly before. (S21) was really happy to swim a length, this is the furthest he has swum in his life.*
New purpose	Swimming providing a new purpose in week		*(S13) was smiling after the session; she was now looking forward and had a purpose to leave the house.*
Sleep	Sleeping better since swimming		*S12 reported 2 positive effects, she is feeling more relaxed, her husband is unwell and waiting for treatment, she is also sleeping better.*

Theme 3: Short-term side effects

Theme three included three subthemes describing some of the short-term side effects experienced from swimming; see Table 50.

Table 50: Theme three: Short-term side effects

Theme 3	**Description**		
Short-term side effects	Short-term side effects from swimming		
Subtheme	**Description**	**Participant data**	**Observational data**
Pain	Increased pain during or after swimming	*'Sometimes it aggravates the pain, others it helps (S5)'*	*(S4) had a slight increase in pain for 24 hours. (S2) was a little bit stiff on Thursday.*
Fatigue	Experienced more fatigue after swimming	*'After swimming my pain doesn't get worse, I'm just tired for the rest of the day (S17)'*	*(S15) was a bit achy and tired that night and Thurs and slight increase in pain*
Minor adverse reaction	Minor adverse reaction related to swimming or being in a pool	*'As I discovered that I am allergy to chlorine & having treatment for my nasal passage (S7)'*	*(S10, S8 and S7) wanted to see if they could do 2 lengths without stopping, we first practiced turns from the wall, I demonstrated first. (S8) rushed and twisted her knee; she had a sharp pain which eased after a minute.*

Theme 4: Barriers

Theme four included eight subthemes describing barriers to swimming; see Table 51.

Table 51: Theme four: Barriers

Theme 4	**Description**		
Barriers	Barriers to swimming		
Subtheme	**Description**	**Participant data**	**Observational data**
Time and cost	Lack of time or the cost of swimming	*'I haven't got the spare time around my work and young son as well as the cost to swim at local pools being too high (S2)'*	*Two participants would struggle to afford to swim regularly as they were not working.*
Caring responsibilities and work	Caring responsibilities and work impacting on spare time	*'I came to Turkey to look after mum who has not been well. When I go back home, I will start swimming again (S9)'*	*(S15) unable to attend as needs to pick up children from school. (S8) will start swimming on the 1st of Feb after she has completed her tax return.*
Co-morbidities	Co-morbidities	*'Still struggle to swim with my shoulder (S14)'*	*(S14) found she had some pain while in the pool on Wednesday, but she pushed on. She spoke*

			about her other pains including right groin and neck and shoulder.
Pool temperature	Low water temperature is a barrier to swimming	*'If the pool had been warmer, I do believe I could have increased the time in the pool (S12)'*	*(S12) got very cold. I will bring a wetsuit. The water temp is 27 due to boiler issues.*
Lack of confidence	Lack of confidence to swim alone	*'Lack of confidence swimming by myself (S21)'* *'Sadly, although I am sure I can swim a reasonable distance due to this course I do not have the confidence to go swimming by myself. Still trying to find a friend who will go with me though! (S21)'*	
Mental health	A mental health condition including anxiety swimming around others	*'My anxiety and panic attack also causing me to lose my confident to stay in the water by myself (S9)'* *'Anxiety around swimming around other people. (S20)'*	*She suffers from panic attacks in confined spaces and sometimes felt the same panic with her face in the water. We practised some breathing control.*
Loss of sensation	Loss of sensation in legs or arms due to spinal condition		*(S21) found it hard to plant feet back on floor from supine and prone, he said he has had less sensation in his legs since the fall 2 years ago.*
Short-term illness	Short-term illness prevents attendance		*(S1) had a cold and couldn't attend*

Theme 5: Enablers

Theme five included four subthemes describing enablers to swimming on completion of the programme; see Table 52.

Table 52: Theme five: Enablers

Theme 5	**Description**		
Enablers	Enablers to swimming		
Subtheme	**Description**	**Participant data**	**Observational data**
Motivation and goal setting	Motivation and goal setting to enable regular swimming	*'My aim is to go at least once per week. At the moment this is what I am doing. (S11)'.*	*(S14) feels happy to swim on holiday now and wants to improve her stamina. (S17) spoke about*

		'I have never been a strong swimmer but am fairly confident in the water and felt very motivated to do this and try and help myself (S10)'.	*how she wanted to lose weight, she has PCOS and changing her diet doesn't help, only exercise.*
Support after programme	Finding long-term support to enable regular swimming	*'I would like to have a series of lessons at my local pool to help me to get used to lance swimming and find quieter times of day before committing to more swimming sessions' (S20)*	*(S13) will book more lessons with local teacher at pool, whom she knows, to gain more confidence and control in the water.*
Exercise routine	Developing an exercise routine	*'Usually Wednesday and Friday, preserve the routine (S19)'*	*S11 will continue at Dover*
Access to swimming	Gaining an understanding of local pools sessions and how to access.		*We spoke about how she could catch the train to the Stour centre, she is not local and hadn't realised that this would be the easiest option.*

7.24.5 Quantitative data

The participants were asked about their experience of swimming with CLBP in the follow up questionnaires on completion of the programme and 6-months later. Most people reported that their CLBP was no different or easier in the water and they were able to do more in the water. After swimming most participants found that they were still able to function and their pain was no worse, and in some cases their pain was easier; see Table 53.

Table 53: Participant experience of swimming with CLBP

	Post programme questionnaire (n=15)			**6-month questionnaire (n=15)**		
Swimming with CLBP	**More**	**Same**	**Less**	**More**	**Same**	**Less**
In the water able to do %(n)	67(10)	27(4)	6(1)	40(6)	47(7)	13(2)
After swimming able to do %(n)	13(2)	53(8)	33(5)	13(2)	67(10)	20(3)
	Worse	**No different**	**Easier or no pain**	**Worse**	**No different**	**Easier or no pain**
During swimming CLBP was %(n)	0(0)	20(3)	80(12)	7(1)	27(4)	67(10)
After swimming CLBP was %(n)	40(6)	27(4)	33(5)	20(3)	40(6)	40(6)

In the post-programme questionnaire, the participants were asked whether further changes were required to the content and delivery of the programme. The data from the questionnaires suggested that it would be feasible to use this swimming programme for most people with CLBP but those who lack confidence may require more sessions. The participants who felt that the number of lessons could be changed would have liked more sessions. 93% of participants agreed that the programme was adapted for CLBP, see Table 54.

Table 54: Participant feedback of swimming programme

Swimming programme	Response (n=15)		
	No changes required	Could be changed	Unsure
Length of session %(n)	93(14)		7(1)
Number of sessions %(n)	60(9)	20(3)	27(4)
Number in session %(n)	100(9)		
Programme adapted for CLBP %(n)	93(14)	40(6)	

The post-programme questionnaire also asked participants whether they would recommend the swimming programme to friends and family. 80% of participants said that they would recommend the programme to friends and family with 20% being unsure as it was too soon to say.

7.3 Discussion

7.31 Feasibility of study procedures

It is recognised that recruitment can be one of the greatest challenges facing a clinical study; researchers often overestimate the number of people who might be interested, who would be available to take part and would need to be approached to achieve the target number for the study (White and Hind 2015). A review of RCTs funded by the NIHR found that 56% of studies achieved their expected target sample size (Walters et al. 2017), highlighting the need for feasibility studies to ensure that barriers to recruitment are addressed prior to conducting a RCT (Blatch-Jones et al. 2018). For this study participants were recruited through posters displayed in the physiotherapy department and by physiotherapists discussing the study during initial appointments. The researcher noted that most people were interested and could understand the purpose of the study and the relevance of the research question, an important factor in the success of a study (Isaksson et al. 2019). The main barrier to recruitment was not being able to attend the pool at the times offered due to work and childcare responsibilities. The times the swimming programme ran had been dependent of availability of the researcher and swimming teacher and the times when the leisure centre was willing to hire the pool. A systematic review exploring why patients take part in research found that perceived benefit in the intervention and confidence in the clinician enhanced recruitment rate and barriers included burden from additional appointments, work, and childcare responsibilities (Sheridan et al. 2020), reflecting the findings from this study. It was acknowledged that a greater range of pool times and additional sites would be required if an RCT was undertaken in the future. Retention rates are usually better than recruitment rates, with an average rate of 89% (Walters et al. 2017), the retention rates were 73% in this study; based upon the data it was anticipated that retention rates could have been higher if the study was not conducted during the COVID-19 pandemic.

Recruitment and retention rates provide useful data, however exploring determinants and whether these factors can be addressed has additional value. In this study changes could be made to the inclusion and exclusion criteria; a large exclusion criterion will reduce the number of eligible participants. On completion of this study, it was found that several exclusions could be removed, for example several participants in the study had a mild shoulder condition but

were able to manage the programme with some minor modifications to their swimming stroke and in two cases the participants found their shoulder condition improved since swimming. The exclusion of spinal injections for 12-weeks could be amended to 6-weeks as rehabilitation is recommended after spinal injections, likewise spinal fractures within 12-months could be amended to 6-months. As this study aimed to test a complex intervention with a heterogenous population in a real-world setting, it would best to consider it to be a pragmatic RCT not a classical RCT. A pragmatic RCT usually has a minimal exclusion/ inclusion criterion to broaden the scope of the findings and to reflect real-life clinical practice (Gamerman, Cai and Elsaber 2019). The study recruited participants through an NHS acute trust hospital; it has been suggested that adopting several different recruitment strategies can be beneficial (Ruban et al. 2019). A future RCT could recruit participants, from the same setting, from GP surgeries appointments and / or via social media thereby recruiting people who have not consulted a health professional. Each option would target a different population of people with CLBP.

Randomisation is considered the gold standard for any clinical trial (Sella et al 2021), in a non-randomised study choice of treatment arm can be influenced by the researcher and participant introducing bias, meaning that outcomes could be related to the intervention or due to other factors (Naci et al. 2017; Suresh 2011). In this study initially the intention was to randomise the participants but due to the limited time the pool could be hired, if the participants were available and wished to take part in the swimming arm then they were offered this intervention, if not they were allocated standard physiotherapy care which offered more choice of appointment times. This pragmatic approach reflected usual clinical practice in that those who could attend and wished to try the swimming sessions were invited to try swimming and those who could not were offered the alternative. More pool time would be sourced for an RCT to enable randomisation of participants.

The data suggested that the comparison group treatment in an RCT would need to be funded to ensure that there was equity to access to treatment in both arms. The physiotherapy waiting list was long during the trial period due to staff sickness due to the COVID-19 pandemic. The data identified that the participants in the swimming arm had more regular appointments and had a shorter wait for treatment that in the standard physiotherapy arm. In physiotherapy research it is common to compare an intervention to a similar intervention

such as another form of exercise (Macedo et al. 2021; O'Keeffe et al. 2020), to an educational booklet (Ferreira et al. 2021) or to standard physiotherapy care (Kloek et al. 2018); as was the case in this study. The problem when comparing an intervention to usual care is that usual care is variable (Williams et al. 2016). Pragmatic RCTs usually use what is known as an active control arm, rather than a no treatment arm (Gamerman, Cai and Elsaber 2019), it is rare for research conducted in a healthcare setting to have a no treatment arm as people will expect some type of treatment if referred into a service (Williams et al. 2016). The researcher found it difficult to keep track of the comparison group, as the participants were being managed under different physiotherapists within the trust. It was also recognised that there was a risk of contamination bias (Robinson et al. 2020), for example in the case of this study those in the control group were not prevented from trying swimming in their own time. In future trials it would be important to find out whether participants in the comparison group tried swimming during the study period. Based upon the findings from this study the comparison group for an RCT could be a group gym session, to improve equity to treatment and to improve ease of monitoring.

Due to the complexity of CLBP and the impact on function, mental and physical health, and quality of life, it is good practice to collect outcomes covering multiple domains (Turk and Dworkin 2004). Multidimensional scales are best for CLBP trials (Younger et al 2009), there are pros and cons with each measure which need to be considered (Faculty of Pain Medicine 2019). This study used the ODI to measure disability, PSEQ to measure pain self-efficacy and the EQ-5D-3L to measure quality of life; these are all common outcome measures used in CLBP trials (Macedo et al. 2021). The ODI is considered to be the gold standard measure for LBP; this questionnaire is composed of 10 questions with 6 response statements and has been found to have acceptable internal consistency and moderate correlation with other measures of pain (Fairbank and Pynsent 2000). The PSEQ is composed of 10 questions scored on a Likert scale asking the participant how confident they are to do an activity despite the pain; it has high internal consistency, reliability, and validity (Nicholas 2007). The EQ-5D-3L is recommended by NICE over the EQ-5D-5L (NICE 2018), it is composed of 5 quality of life questions with 3 levels of response and a 6^{th} question which is scored on a 100-point scale regarding health state (EQ-5D 2015). Although function and disability could be considered opposing binary concepts, they are on a continuum and despite this study used the ODI it may

have also been worth using the patient specific functional scale which measures function (Horn et al. 2012), providing an objective marker. There are several limitations with outcome questionnaires, it is understood that internal and external factors impact responses (Kluzek, Dean and Wartolowska 2022), in the case of this study the scores did not always reflect on what the participant was able to do during the sessions. For example, the highest ODI score in this study was 80-100% which would indicate that this participant was bed bound, however the participant in question was able to drive to the pool, change and complete the session. The questionnaire is therefore measuring the participants perception of disability, not actual disability; it is recognised that both constructs are equally important. Another problem with outcome measures is the impact of comorbidities when scoring, many of the participants in this study were not dealing with just CLBP and responses might be related to another condition, not just CLBP.

Compliance completing outcome questionnaires has been found to be 84-97% and will vary depending on the population you are studying (Atherton et al. 2016). In this study it was found that initial online questionnaires were completed with less prompts than the post programme questionnaires; some people had to be sent a paper copy after failing to complete the online version after the programme. A study by Ebert et al. (2018) found that the response rate was 10% lower with digital than paper questionnaires but that paper questionnaires had more missing values, this seemed to be the case also in this study. Researchers sometimes consider whether the length of a questionnaires is the cause for poor response rates; however, there is no consensus on what is considered long or short and it maybe that overlap in questions is a greater burden (Rolstad, Adler and Ryden 2011). One participant's feedback after completing the three questionnaires was '*I must apologise for the lateness of completing the forms. I am now in pain and very tired,*' illustrating the extra burden of completing the questionnaires for this population. In a future study the questionnaires could be completed in paper form after the session in the café. The assessment of swimming ability was conducted by the swimming teacher and researcher at the end of the programme, future studies could consider using a scale such as the Modified Erbaugh Rating Scale for front crawl swimming (Bradley, Parker and Blanksby 1996).

It is essential to monitor safety outcomes in a trial of a new intervention (Turk and Dworkin 2004), this was done by asking participants how they felt at the start of each session after the

last session, which is usual practice with any physiotherapy intervention. Some studies only capture data passively (Smith et al. 2020) but in the case of this study active capture was used through direct questioning. The participants in the study were managing other comorbidities and these sometimes impacted on their ability to attend the session or the type of swimming they could manage. One third of the participants in the swimming group had asthma, they were advised to keep their pump on the side of the pool, but no one required it during a session. Prior research has found that swimming for less than 90 minutes does not exacerbate asthma and it can be good for lung function (Paivinen et al. 2021; Ramachandran et al. 2021). Some participants in the study had fibromyalgia, they found that the swimming had a short-term impact on fatigue in the first few sessions; prior research has found that swimming can improve pain and function in people with fibromyalgia (Fernandes et al. 2016). One participant developed high blood pressure and headaches, this did not coincide with the session, but she had to leave the study whilst her medication was adjusted. Two participants had short-term adverse reactions to their COVID-19 booster vaccination, and they had to miss a session and another developed pericarditis and missed the last two sessions.

The pool temperature varied from 27-29°C, at one period during the study the boiler broke, and the pool temperature was 27°C. Three swimmers felt cold if they were in the pool too long and one swimmer bought a short wetsuit, to enable her to swim in cooler water. The most popular temperature amongst participants was 29°C. Two minor adverse reactions were reported during the study. The first related to a set of goggles not fitting correctly, this problem resolved within ½ hour, and a larger set of goggles was provided. The other was that a participant developed a mild chlorine allergy resulting in mild cold symptoms after the session. The issue with goggles reinforced the importance of ensuring that they are able to fit their goggles correctly during the first session and having a range in sizes and styles. It is well known that some swimmers can develop a mild chlorine allergy, this can often be mitigated by wearing a nose clip (Kanokowska et al. 2018).

7.32 Feasibility of the Swimming Programme as a Rehabilitation Modality for People with CLBP

Feasibility studies do not just test the trial procedures, they can also evaluate the feasibility of new interventions (Abbott 2014), as was the case in this study. The swimming programme had been developed based upon four objectives and had not been trialled prior to this study.

7.32.1 To improve confidence swimming with back pain, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for back pain

The data for the first objective showed that for most participants, swimming ability improved over the six sessions, nevertheless the nervous swimmers felt that they would have liked more sessions. The analysis of the qualitative data suggested that improved swimming confidence enabled regular swimming and lack of confidence was a barrier to swimming. Swimming confidence and ability are often considered together, however on reflection they are different outcomes. Confidence is defined as '*the quality of being certain of your abilities*' whereas ability is defined as '*a skill needed to do something*' (Cambridge dictionary 2023a; Cambridge dictionary 2023b). Confidence can be difficult to measure, it is not a binary state but, on a continuum, whereby confidence can be developed but also be lost. Swimming confidence can be assessed by asking the swimmer or as the observational data showed it can be evaluated by others through conversation and actions. The aim of the first stage on the Swim England adult learn to swim framework is to become water confident, there are 18 learning outcomes to pass to complete this stage (Swim England 2023). The learning outcomes are aquatic skills for example being able to regain an upright position from on the front with support, two outcomes mention being at ease doing an activity. The framework assumes that if the person develops aquatic skills, they will become water confident. For some people learning these aquatic skills will translate to developing swimming confidence however this correlation will not apply to all. For some people, particularly those who suffer from anxiety extra time, support and encouragement may be required, these factors should be considered in future delivery of the swimming programme.

93% of participants agreed that the programme was adapted for CLBP; under the theme, *delivery of the programme*, various strategies were mentioned in how problem solving was used to adapt swimming for CLBP. Adaptive swimming has been used with people with

disabilities for many years (Dunlap 2009; Ethridge, 2022), however there has been no prior research exploring adaptive swimming in people with CLBP. Further research could be undertaken to explore which adaptations people with CLBP should consider and methods for learning adaptations.

7.32.2 To integrate pain management skills with swimming

There are a wide range of pain management skills used by pain clinics and physiotherapists (Pain tool kit 2023). The theme *enablers* included the following skills, goal setting, prioritising, building a support team, and developing exercise routine. Several evidence-based physiotherapy led rehabilitation programmes for people with chronic pain have also integrated similar pain management tools in their programme (Hurley et al. 2007; Hurley et al. 2022; Lamb et al. 2010). The swimming programme had incorporated several strategies to enable people with CLBP become regular swimmers including goal setting and making an action plan, signposting to specific sessions, and providing information about access to local pools and the group sessions allowed participants to build a peer support group. Signing up for the study allowed the participants to prioritise exercise during their week and to start to develop an exercise routine. It was recognised that further refinement of the swimming programme may be required to improve the integration of these skills and other skills to optimise this section of the programme.

7.32.3 To recognise and address barriers to swimming to enable people with CLBP become regular swimmers

The swimming programme was designed to enable the swimmers to continue swimming on a regular basis following completion of the programme. It has been found that adherence to exercise in people with CLBP can range between 50 and 70% (Beinart et al. 2013). Prior to the swimming programme only one participant had swum regularly, and most hadn't swum for many years. On completion of the programme 88% of participants intended to carry on swimming and the 6-month survey found that 60% of the participants continued to swim on a regular basis. Other large studies involving rehabilitation for chronic pain also collect long-term outcome data, but this usually is in form of outcome measures, not whether participants are still exercising and how frequently (Hurley et al. 2007; Lamb et al. 2010). The additional

data collected in this study could provide a better understanding of the long-term impact of rehabilitation on levels of physical activity.

On completion of the programme the participants were asked about barriers and enablers impacting engagement in swimming; the most common barriers were cost, time, pool temperature, swimming ability, pain after swimming, and lack of motivation. The theme, *barriers* identified ten barriers including: *time, cost, caring responsibilities and work, co-morbidities, pool temperature, lack of confidence, mental health, loss of sensation, and short-term illness.* The inclusion of both quantitative and qualitative barriers data during this study was advantageous as the quantitative data identified the most common barriers and the qualitative data highlighted barriers which hadn't been considered in the survey in study one. These included caring responsibilities and work pressures, co-morbidities, lack of confidence, mental health, loss of sensation and short-term illness; these additional barriers could be considered during the refinement of the swimming programme.

7.32.4 To use swimming to improve function, physical activity, quality of life, physical and mental health, and weight management

Prior to the study only one participant was engaging in formal exercise, 6-months after completing the programme 80% of participants were still swimming or engaging in formal exercise. The UK government recommends that adults engage in at least 150 minutes of moderate physical activity per week, this would include swimming (GOV.UK 2019). There is sufficient evidence that being physically active has a positive impact on physical and mental health, however the relationship between physical activity and CLBP is unclear (Hendrick et al. 2011). Furthermore, there is some evidence that there is a u-shaped relationship with physical activity in that too little and too much physical activity could have a negative impact on the management of CLBP (Heneweer, Vanhees and Picavet 2009). Physical activity includes daily life not just formal exercise, in research studies levels of physical activity are sometimes measured using devices such as pedometers. This study only asked about swimming and new forms of exercise; therefore, it was not possible to comment on total physical activity; future research could explore pedometers or smart watches as an outcome measure for physical activity.

The outcome questionnaires measured pain self-efficacy, daily function, quality of life; these outcome measures were chosen as they reflect common rehabilitation goals and included measures for physical and mental health. For the purpose of this study, as it was underpowered and only designed to test feasibility, only descriptive statistics and within group treatment effects can be described (Abbott 2014). There were within group differences in both arms suggesting that for this group of participants they had experienced small improvements in levels of disability and PSEQ, the differences were greater for the ODI. It was recognised that the baseline scores were higher in the swimming arm than the physiotherapy arm for all three measures, suggesting that a stratified randomisation process would be required in a future trial. Prior to starting the programme, the participants had been asked what they hoped to achieve by attending the programme; answers included to gain more movement, regain confidence, lose weight, reduce pain, improve mental health, improve fitness, strengthen muscles, and sleep better. The analysis of the qualitative data had highlighted some of the therapeutic benefits experienced during the programme such as improvement in mental health and wellbeing, mental health, flexibility, enjoyment, confidence in swimming and sleep. Considering this additional data outcome measures may need to be revised as neither the ODI nor PSEQ cover these dimensions. In future studies alternative outcome measures could be considered such as the Warwick-Edinburgh Mental Wellbeing Scales (Tennant et al. 2007) and the Measure Yourself Medical Outcome Profile (MYMOP) (Paterson 1996).

7.33 Data to Guide Refinement of the Swimming Programme

Two of the core elements of the MRC framework are stakeholder engagement and refining the intervention. It was recognised that as the swimming programme was a newly developed intervention, it would need to be refined based upon stakeholder feedback and guided by programme theory (Skivington et al. 2021). The NIHR recommend that patient and public involvement in research should be an active partnership between researchers and the public at all stages of the research process (NIHR 2023). It was acknowledged that the researcher and the swimming teacher could not experience the swimming programme as participants so the feedback from the participants was crucial when refining the swimming programme. The

researcher and swimming teacher, however, were able to experience the process of delivering the swimming programme and document their observations and experience on the session plans. It could be suggested that gaining data from all stakeholders in this manner to be used in the refinement of the swimming programme could improve the acceptability and usability of the swimming as a rehabilitation modality. The themes and subthemes developed from the post programme questionnaires and observational data highlighted the broad range of experience when taking part and delivering the swimming programme. It was recognised that the themes integrated with other core elements within the MRC framework, including considering the context and identifying key uncertainties and could be used to guide future COM-B, BCW and logic model analysis. Further information about the outcome of the combining of this data with the data from the other three studies can be found in the meta inference chapter, alongside recommendations for refinement of the swimming programme.

7.34 Generalisability of the Findings

Generalisability, also known as external validity, refers to whether a study sample represents a target population and whether the study findings are generalisable in clinical practice (Kamper 2020). Generalisability is on a continuum, there are two considerations when assessing generalisability, the sample size and the sample selection (Murad et al. 2017). Thirty two people with CLBP were recruited for this study, this sample size would not adequately represent the CLBP population seeking care. However, it was recognised that it is not usual practice to recruit a large sample for a feasibility study and the sample size for this study aligned with the median sample size used in other feasibility studies undertaken in the UK (Totton et al. 2023). The eligibility criteria, demographics and baseline scores impact on the sample selection. The eligibility criteria for this study was set to ensure the safety of the participants, it reflected the usual screening process used for people with CLBP undergoing aquatic therapy. It would be considered unsafe to offer rehabilitation in a pool if a person did not meet this criteria; for example, some people may require a surgical or medical intervention, not rehabilitation. The study sample was representative of the CLBP population who were safe to engage in aquatic based rehabilitation. The sample included people with a wide range of ages (27-72 years) and number of years with CLBP (0.5-52 years), suggesting that the findings could be generalisable within these parameters. 70% of the sample were female, reflecting the greater proportion of females to males in the CLBP population (Freidin

et al. 2021). 86% of people in the swimming arm identified as White British; in Kent 83% of the population and in England and Wales 81.7% of the population identify as white (GOV.UK 2023; Kent County Council 2024), suggesting that the sample wasn't representative of the local and national ethnic minority populations. The outcome scores from the ODI highlighted the median disability scores for the swimming arm sample was severe disability, suggesting that the findings may be more generalisable to the CLBP population with a higher level of disability.

7.35 Strengths and Limitations

Unlike biomedical research when evaluating a rehabilitation there are many variables which can't be controlled, which impact on outcomes, including prior treatment and daily life. Most participants recruited in this study had received standard physiotherapy care prior to enrolling in the study. It was recognised that the participants in the swimming arm continued with the advice provided during previous sessions of physiotherapy, for example following a home exercise programme and the swimming programme was an additional rehabilitation modality. It could therefore be suggested that the study compared additional sessions of physiotherapy care to the swimming programme. This is not always acknowledged by researchers but is common with most studies involving people with CLBP. Daily life also impacted the study, for example participants were unable to get to the pool due to changes in childcare arrangements or unexpected transport issues before the session and external impacts such as falls, and slips; these factors could have also impacted the study findings. Furthermore, there were additional variables due to the time period the study was conducted; the data identified that the COVID-19 pandemic and measures had an impact on attendance to the class and outcome data. For example, the COVID-19 booster vaccine program was being run and several participants experienced short-term adverse reactions which resulting in them missing a session or feeling unwell. COVID-19 also resulted in one participant needing to isolate and having to miss a session. Despite the challenges, conducting research in a real-life setting ensured that the findings were applicable to real-life, it is usually found that in a larger RCT the impact of these variables becomes less significant.

Initially the intention was to randomise the participants but due to the limited time the pool could be hired, if the participants were available and wished to take part in the swimming arm

then they were offered this intervention, if not they continued with standard physiotherapy care. This pragmatic approach reflected usual clinical practice in that those who could attend and wished to try the swimming lessons were invited to try swimming and those who could not were offered the alternative. A lower number of male participants 23% were recruited for this study, however this could reflect the greater number of women suffering from CLBP, particularly in the over 50 age group (Wang et al. 2016).

There were several strengths identified in the design and conduct of the study. The study budget enabled the researcher to pay for the swimming teachers time, hire the pool, buy swimming equipment for the group and individuals, and pay for travel, reducing the impact of health inequality. Financial support is an area of feasibility that should not be overlooked as this is one factor for trial success (Isaksson et al. 2019). Another strength was that it was conducted in a real-world setting, a place that people can continue to swim independently in the community. Several people in the group joined the leisure centre after taking part in the trial. Furthermore, the public and pool staff in the leisure centre took an interest in the study; conducting research in the community allows the public to understand more about research and this level of public engagement is important for future work. The study design enabled the study procedures to be examined and improvements can be made prior to running a RCT, based upon feedback from the stakeholders, experience during the trial and the questionnaire and observational data.

7.4 Conclusions and Recommendations

The study procedures were found to be feasible with minor modifications, no serious adverse events or safety issues were identified during the study. Sufficient participants were recruited during the time period, with high levels of retention; however future studies should aim to offer a greater range of pool times. The findings suggest that the swimming programme improved swimming and pain management skills and enabled people to adapt swimming strokes for CLBP. Participant feedback was positive, many wanted more sessions in order that they could gain further skills and confidence when swimming. 80% of participants said that they would recommend the programme to friends and family with 20% being unsure as it was too soon to say. Additional barriers to swimming in this population were identified int his study, nevertheless 60% of people were still swimming at 6-months following completion of the programme. Swimming could enable more people with CLBP to become more physically active, meeting government guidelines for weekly physical activity and have a positive impact on physical and mental health, function, and quality of life. Further research is required but it is hoped that this feasibility study will support refinement of the swimming programme, future funding applications and the development and conduct of a large RCT.

Chapter Eight: Refinement of the Swimming Programme through the Integration and Analysis of Data from Four Studies

8.0 Introduction

It was recognised that the programme developed in study three and trialled in study four would require refinement and further development. In the case of this project there are several approaches which could be considered to guide the refinement process: including stakeholder feedback, synthesising, and analysing the data from the existing four studies, and undertaking further developmental research. The post-programme surveys in study four collected stakeholder feedback, providing an insight into expectations and experience. The feedback could be used to enable refinement of the programme to the service users' capabilities and needs. It was also recognised that combining the quantitative and qualitative data from all four studies could provide a broader and more comprehensive overview when delivering a swimming programme to this population, as several research approaches had been taken with different stakeholders. Mixed methods research involves more than just the collection of qualitative and quantitative data; the data is combined and analysed in order to enhance the value of the findings (Creswell and Clark 2007). There are several reasons for combining data including using qualitative data to determine the validity of quantitative findings, using quantitative data to explain findings from qualitative research or mixing data can be used to refine interventions (Fetters, Curry, and Creswell 2013). Meta inference is '*an inference developed through an integration of the inferences that are obtained on the basis of qualitative and quantitative strands of mixed methods study'* (Tashakkori and Teddlie 2003, p.710). It was not known whether the findings from each study converged or contradicted the findings from other studies or whether new insights could be discovered through combining the data. It was recognised that future research in the field could be guided by stakeholder feedback, and the synthesis and analysis of the data from all four studies. The results from the stakeholder feedback was presented in the previous chapter; the first part of this chapter will focus on the synthesis and analysis of the data from all four studies. The aim of combining the data from all four studies was to consider whether the objectives and sections of the programme should remain, be developed further, or revised.

8.01 Research Question

What refinements should be considered in the future development of the swimming programme?

8.02 Study Objective

To combine the data from all four studies and draw meta inferences to enable refinement of the swimming programme.

8.1 Methods

The integration and analysis of findings from all four studies in this project was based on the process used in study three, described by Skamagki et al. (2022), Gutterman, Creswell and Fetters (2015) and Fetters, Curry, and Creswell (2013). The authors recommend using joint display tables which enable organisation and analysis of mixed methods datasets. In the case of this project the joint display were documented as eleven tables which covered the different sections of the swimming programme, see Appendix Q. The purpose of combining the data, making meta inferences and interpretations from all four studies was to consider whether the objectives and the content of the different sections of the swimming programme should remain, be developed further, or revised. Study three, which described the newly developed swimming programme is found in the first column of the table, and the content of the programme was compared to the quantitative data from study one, the qualitative data from study two and the multi-methods data from study four. The final column of the table documents the meta inferences and interpretations, which include the following options: convergence, divergence and complimentary. Convergence or congruence refers to a positive relationship between the data whereas the term divergence is used when there is a lack of agreement and complimentary is used when new insights are discovered during the mixing of data (Skamagki et al. 2022). In sections where there is convergence in the data the section of the programme will remain the same, for the other two options the programme could be changed or refined based upon the inferences or further research may be required.

8.2 Results

The meta inferences developed when combining the data from study one, study two and study four suggested that some sections of the swimming programme developed in study three required no changes, but some areas may benefit from further development. Table 55 summarises the study characteristics and Table 56 documents where the data converged, diverged or the findings were complimentary. The joint display tables are located in Appendix Q.

Table 55: Study characteristics

Key information	**Study one**	**Study two**	**Study three**	**Study four**
Methodology	Quantitative	Qualitative	Mixed methods	Multi methods
Study design	Survey	Semi-structured interviews	Modified Delphi study	Non-randomised comparative trial
Time horizon	Cross-sectional	Cross-sectional	Longitudinal	Longitudinal
Participants	People with CLBP under NHS physiotherapy or orthopaedic clinics in secondary	Swimmers with CLBP not under a healthcare professional	People with CLBP Physiotherapists Swimming professionals	People with CLBP under NHS physiotherapy or orthopaedic clinics in secondary
Number of participants, n	82	14	17	32
Female, %, (n)	62, (51)	71.4, (10)	Not applicable	77.3, (17)
Median age y, (IQR)	52.5, (21.75)	Unknown	Not applicable	56, (33)
Median time with CLBP, y, (IQR)	10.5, (17)	25 (10)	Not applicable	7, (14.25)
Frequent swimmer %, (n)	25.6, (21)	100, (14)	Not applicable	Start of study 4.5, (1) 6-months after study 60, (9)

Table 56: Summary of meta inference tables

Convergent findings	**Divergent findings**	**Complimentary findings**
Programme set up: Number in session	Programme set up: Frequency and number of sessions	Programme set up: Length and time of session
Pre-programme information: All sections	Teaching / coaching approach: Less concern about technique	Teaching / coaching approach: Kinaesthetic / problems solving
Delivery of programme: Physiotherapist and swimming professional	Warm up: Relaxation and floating	Session brief: All sections
Teaching / coaching approach: Subgrouping back pain, physical activity, and fun	Cool down: Walking	Session debrief: Explain how person might feel after session and what to work on
Session debrief: Teaching points, positive feedback, and reflection on session	Regular swimming: Fun and sociable, peer support group	Warm up: Low intensity swimming
Warm up: Awareness activities, stretches, walking, sculling		Cool down: Low intensity swimming
Cool down: Stretches, sculling, gentle movements with a fun element		Core aquatic skills: floating, sculling, hybrid strokes, treading water, Breathing exercises, gliding
Core aquatic skills: cope with a painful episode, entries and exits, changing position in the water, awareness exercise		Swimming strokes: Front crawl, backstroke, and breaststroke
Regular swimming: Reflection, positive feedback, specific sessions, family / friends' session, setting goals		Regular swimming: Discounted swimming, information about local pools, further drop-in sessions
Programme objectives		COM-B and BCW analysis of programme objectives

8.3 Discussion

8.31 Programme Set Up

Parameters had been suggested for the programme set up; when the data was integrated the suggested number of participants in the session was congruent, the frequency and number of sessions was divergent and new insights were observed for the length and the time of the sessions. The feedback from the post-programme questionnaire in study four was congruent with the proposed number to be included in the swimming programme developed in study three, therefore no changes were required. The post-programme feedback from study four identified that only 60% agreed that offering six sessions over three weeks was appropriate for someone with CLBP, and it was suggested that less able and confident swimmers may require more sessions. The theme '*How swimming looks for me*' from study two explored not just the frequency of sessions but the confounding or supporting factors to becoming a regular swimmer, such as work and family pressures and the data from study one found that almost half agreed that they would find it hard to find the time to swim during the week. The data suggested that although people are aware that regular swimming sessions could be beneficial for learning and health, there are several barriers which could impact engagement in the long-term. Therefore, in future delivery of the programme further support and behaviour change techniques may be required, and additional sessions could be provided to less able swimmers. The post-programme feedback found that 93% agreed that the sessions were the correct length, the participants discussed the importance of not overrunning, building up gradually and choosing a warmer pool. A wide range of times had been suggested in study two and three, however the findings from study four provided clearer guidance. In future trials the programme would start at 30 minutes and run for no more than one hour, aligning with another swimming study which delivered an incremental swimming programme (Manshouri and Rahnama 2014). The feasibility data from study four had highlighted that the times offered for the sessions was a barrier to recruitment and that some people recruited for the study could not attend all sessions. A wide range of times were discussed in study two under the theme '*How swimming looks for me'* and the data from study one had identified the most popular times were between 9-12pm and 5-7pm. In future trials of the programme a greater range of times could be offered for people to allow inclusion of people who work and those with caring responsibilities. It would be difficult to find a time which suited all,

offering a range of times would be the best option. This would align with recent service standards published by the CSP which recommend that frequency, timing, and intensity of physiotherapy sessions should be flexible to the individual (CSP 2021).

8.32 Pre-programme Information

Three pre-programme questionnaires had been developed to screen and develop an understanding of the participants' general health, back pain, and swimming ability. When the data was integrated the suggested content of all three questionnaires was found to be congruent. The data collected through the three pre-programme questionnaires in study four identified that the participants were heterogenous with regards to general health, back pain and swimming ability and the questionnaires enabled the swimming teacher and physiotherapist to get to know each participants and ensure that the sessions were run safely. The safety data from study four provided evidence that sufficient information had been collected prior to starting the programme, minimising risks, and enabling the sessions to be run safely. The data from study one had highlighted some of the functional barriers and concerns people with CLBP could face when accessing and using a pool, these had been included in the pre-programme questionnaires so that sufficient support could be provided. The content of the swimming ability questionnaire was supported by the data collected in study one which had highlighted that only a quarter had been swimming the previous month and the theme '*Learning to swim with back pain*' from study two illustrated the range of swimming backgrounds in this population. The content of the back pain questionnaire was supported by the barriers identified in study one and the theme '*My back pain journey*.' These pre-programme questionnaires could be used in future trials of the programme, no additional questions were required.

8.33 Delivery of Programme

It had been suggested that the programme should be delivered by a physiotherapist and a swimming teacher; when the data was integrated this collaboration was found to be congruent. The subtheme '*My swimming journey*' and '*My barriers to swimming and how I overcome them*', and the data from study one supported this mode of delivery. Indeed, the data from the post-programme questionnaire suggested that the participants found support from both professionals helpful; therefore, this collaboration would be used in future delivery of the swimming programme. This mode of delivery would align with a recent project undertaken by the CSP stakeholders known as '*Collaborate, Don't Compete*' which encourages optimisation of the available workforce when delivering rehabilitation interventions (CSP 2023).

8.34 Teaching and Coaching Approaches

Three teaching or coaching approaches had been suggested for the programme; an approach which takes into account the different types of CLBP, an approach which focuses on swimming being used to increase levels of physical activity, making swimming fun with less focus on swimming as a form of exercise and less concern about technique and a kinaesthetic problem-solving approach. The integration of the data was congruent an approach which took into account the different types of CLBP; a process known as subgrouping or stratification. The pre-programme back pain questionnaire had highlighted that people with CLBP have different aggravating and easing factors which could be considered when delivering the swimming programme and the theme '*Delivery of programme'*, subtheme '*Heterogeneity*' from the qualitative data from study four reported that different strokes were more comfortable for different participants. Furthermore, the subtheme '*How I swim with back pain'*, from study two had described different methods of swimming with LBP and changes to stroke due to CLBP. Some researchers have suggested that stratification based upon prognostic factors, underlying mechanism, and response to treatment, could provide more targeted treatment for people with CLBP (Foster et al. 2013), however other researchers have proposed that subgrouping takes a reductionist approach which does not recognise the BPS model and complexity and uniqueness of CLBP experience (O'Sullivan et al. 2018). Nevertheless, based

upon the findings from this project the pre-programme questionnaires could enable the delivery of a stratified approach to delivering swimming within the programme. Further research would be required to discover which method of stratification to utilise.

The integration of the data was both congruent and divergent for an approach that focuses on swimming being used to increase levels of physical activity, making swimming fun with less focus on swimming as a form of exercise and less concern about technique. The theme '*Enablers*', subtheme '*Enjoyment*' from the qualitative data from study four reported that the participants enjoyed the fun activities, they appeared to be less conscious about having CLBP during these activities, aligning with the suggestion that an aquatic environment can offer a more enjoyable and fun place to exercise (Becker and Cole 1997). Although the survey in study one found that almost a third of people reported that they did not enjoy swimming this could be because there are several ways swimming can be practised. Pain research has found that humour and laughter can have a positive impact on pain threshold (Dunbar et al. 2012; Pérez-Aranda et al. 2019), supporting the inclusion of a fun element to swimming. The subtheme '*Problem solving and adapting*' from the qualitative data from study four suggested that technique was important, participants reported less or no LBP when they made improvements to their swimming technique. Likewise, the theme '*How I swim with back pain'* from study two supported the suggestion that technique could be important; conflicting with the proposition from study three that the programme should be delivered with less concern about technique. There are different styles of swimming each stroke; it has been suggested that some stroke styles could have a negative impact on LBP (Cole et al. 1997; Coleman, Persyn and Winters 2000), implying that if it is possible to change the style of stroke to lessen discomfort, then this approach should be considered.

When the data was integrated new insights were observed for adopting a kinaesthetic problem-solving approach whereby participants consider how their body feels when they are swimming, and they make changes to their stroke based upon how they feel. The subtheme '*How my back feels when I swim'* and '*How I swim with back pain'* from study two suggested that people use kinaesthetic and problem-solving methods when learning to swim with CLBP. The subtheme '*Problem solving and adapting*' from the qualitative data from study four supported the use of a kinaesthetic and problem-solving approach to swimming, however the observational data suggested this approach should be facilitated with sufficient

support from the swimming professional and physiotherapist. Unlike the more experienced swimmers in study two, the swimmers in study four required more guidance when adopting this approach. This findings aligns with the guided discovery approach taken by Swim England when teaching novice swimmer and accounts from more experienced swimmers who have adapted swimming technique to manage an injury (Swim England 2019; Walker 2016). An approach whereby there is more guidance when problem solving could be used in future delivery of the swimming programme.

8.35 Session Brief and Debrief

Four sections had been suggested in study three for the session brief section; when the data was integrated for the session brief new insights were observed for all four sections. The pre-programme questionnaire had asked for specific aims when attending the programme. The subtheme '*Motivation and goal setting'* from the qualitative data from study four included the wider benefits of swimming such as the impact on weight and mental health; these benefits were also highlighted as common enablers in study one. Over 50% of participants in study one had agreed that not being sure which stroke is beneficial for CLBP could be a barrier to swimming, therefore the brief included this topic in the discussion. The post-programme questionnaire identified that only 15.4% reported this barrier, suggesting that more discussion about strokes may be required if some people are still unsure. The participants shared personal aims in the pre-programme back pain questionnaire, these aims could be integrated into future versions of the session brief.

The brief included discussion about concerns, fears and barriers to swimming and swimming with CLBP; a third of participant in study four had reported fears, worries and phobias about swimming, the data suggested that more personal concerns should probably be addressed in the pre-programme 1:1 appointment. The subtheme '*Lack of confidence*' from qualitative data from study four noted that several participants had chosen to wear a cotton t-shirt and shorts when learning to swim. This concern about swimwear had also been highlighted in study one, whereby 44% of people in the survey reported that feeling uncomfortable in a swimming costume could be a barrier to swimming. In future delivery of the trial participants could receive further guidance on the wider choice of swimwear now available including

leggings, short and long-sleeved t-shirts, swim dresses and shorts (Swim England 2022). The theme '*Short-term side effects*' from qualitative data from study four noted post exercise effects; these were similar to other studies involving exercise for this population (Geneen et al. 2017). The proportion of people who could expect to experience a short-term increase in LBP when new to swimming could be calculated from post-programme questionnaire data and shared in the sessions brief with participants in future trials of the programme. No changes to the content of the safety brief were required however the observational data from study four noted that participants sometimes arrived late, and the briefing had to be covered again. In future delivery of the programme participants could be invited to arrive 10 minutes early to allow for late arrivals.

Five sections had been suggested for the session debrief section; when the data was integrated, three sections were congruent and for two new insights were observed. The sections which were congruent were the teaching points, positive feedback, and reflection on the session. The theme '*Delivery of programme'* from qualitative data from study four supported the inclusion of the discussion of teaching points and the post-programme questionnaire supported the use of positive feedback and reflection; these could be used both in the session brief and during the sessions, no changes were required. New insights were observed in the section which included what to work on before the next session, goals, and motivational tools. The data from study one reported that 61.7% of participants thought that setting goals and making an action plan could enable them to swim more regularly and 57.1% of participants in the post-programme questionnaire agreed with this enabler. Although this motivational tool could work for some participants, the data from study one and four suggests that other motivational tools, such as the use of technologies (Tate, Lyons, and Valle 2015) could be considered in future delivery of the programme.

8.36 Warmup and Cool Down

Seven warmup activities had been suggested for the programme; when the data was integrated four activities were congruent, two were divergent and for one new insights were observed. The activities which were congruent were the awareness activities, stretches, walking and sculling. The subtheme '*Aquatic skills'*, from the qualitative data from study four

suggested that the most popular warmup and the one that allowed acclimatisation was the walking, aligning with another swimming programmes used with people with CLBP (Winter and McCauley-Callagy 2002). The observational data also documented that the stretches on the side with the resistance band and the knees to chest stretch in the water were well tolerated and it was found that sculling could be integrated into different warmups. The activities which was divergent were the relaxation and floating, the subtheme '*Pool temperature*' from the qualitative data from study four reported that the water felt cold to the participants, therefore this activity was left to later in the session. When the data was integrated new insights were developed with regards to the use of low intensity swimming in the warmup. The subtheme '*Aquatic skills'* from the qualitative data from study four suggested that only the more able swimmers would use this in the warmup, and the subtheme '*My training regime'* from study two, also suggested that only the more able swimmers used low intensity swimming in their warmup, therefore in future trials low intensity swimming would only be included in a warmup for more able swimmers.

Seven cool down activities had been suggested for the programme; when the data was integrated five activities were congruent, one divergent and for one new insights were observed. The activities which were congruent were stretches, sculling on back, floating, changing strokes and gentle movements with a fun element. The subtheme '*Aquatic skills*' from the qualitative data from study four suggested that the knee to chest stretch, sculling on the back with breaststroke legs, floating with a woggle and the gentle movements with a fun element were well tolerated. With reference to the inclusion of low intensity swimming or changing the stroke from the one include in the main set; new insights were observed when the data was mixed. The subtheme '*Aquatic skills'* from the qualitative data from study four documented that for the cool down the participants changed strokes but did not reduce the intensity, unless the intensity had been high in the later part of the session. With regards to divergent findings the observational data did not record walking being used in the cool down, despite being a popular warm up activity.

Warmups and cool downs are recommended for both recreational and competitive swimmers to prepare them mentally and physically for swimming and to enable the body to return to its resting state after swimming (Austin and Noble 1994; STA 2018; Swim England 2019). Warmups are used by competitive swimmers to improve performance and reduce the risk of

injury; strategies include active in-water and dryland warmups and passive warmups, whereby hot showers, saunas, and heated vests are used (Neiva et al. 2014; Tessaro et al. 2017). In-water warmups include different volumes of swimming, gradually increasing in the intensity and dryland warmups include calisthenics, strength exercises, the use of a vibration device and passive and dynamic stretches (Cuenca-Fernandez et al. 2022; Neiva et al. 2014). Despite the breadth of research in competitive swimmers, little research has been undertaken in female competitive swimmers and no research has been undertaken in recreational swimmers, older swimmers, and those with co-existing conditions (Cuenca-Fernandez et al. 2022). Furthermore, the current guidance on warmup activities provided by Swim England (Swim England 2023) may only be suitable for younger competitive swimmers without co-existing conditions. The integration of data suggested that the activities included in the programme were simple to perform and were found to be suitable for people with a wide range of swimming abilities. In the future it would be worthwhile undertaking research looking into the value, duration and content of warm-ups and cool downs for recreational swimmers, including warmups involving passive strategies.

8.37 Core Aquatic Skills

Ten core aquatic skills activities had been suggested for the programme; when the data was integrated four activities were congruent and for six new insights were observed. Learning how to cope with a painful episode when swimming, entries and exits, changing position in the water, sculling and awareness exercises activities were congruent when the data was integrated; therefore, they would be included in future delivery of the programme. The data from study one reported that 31.3% of participants agreed that they were worried that swimming would make their back pain worse and the subtheme '*Aquatic skills'* from the qualitative data from study four suggested that learning to cope with a painful episode while swimming was a valuable skill. Entries and exits had been discussed by the swimmers in study two under subtheme '*Where I swim*' and 29.3% of participants in study one agreed that they would find it difficult to get in and out of the pool. The observational data from study four had highlighted that access from the changing rooms to the pool and methods of getting in and out of the pool should be discussed and practised.

Pain when changing position in the water had been discussed under the subtheme '*How I swim with back pain*' in study two, the subtheme '*Aquatic skills'* from the qualitative data from study four suggested that learning to change position in the water had enabled the participants to put less strain on their back. It is understood that many people with CLBP struggle with pain and move differently when performing common functional tasks involving changing position (Ippersiel, Robbins, Preuss 2018); it could be suggested that this aquatic skill could act as a rehabilitation tool for restoring normal movement when changing position, as well as developing swimming skills. There is evidence to suggest that the practice of mindfulness can improve pain, mental health, and quality of life in people with CLBP (Smith and Langen 2020). The subtheme '*My feelings about swimming'* in study two had indicated that being in the present moment when swimming could be valuable when learning to swim with CLBP and the observational data supported the use of this exercise as an aquatic skill.

New insights were observed for the following activities: floating, sculling, hybrid strokes, treading water, aquatic breathing, and streamline gliding; these insights could be integrated into future delivery of the programme. The subtheme '*Aquatic skills'* from the qualitative data from study four suggested that floating was best learned after learning to glide, this finding correlates with what is known about the static and fluid properties and the impact on body stability (Becker 1997). Sculling had been discussed under the subtheme '*My training regime*' in study two, the observational data from study four had found that sculling was a useful skill to integrate into other activities, including treading water, hybrid strokes, developing a feel for the water and it could be used during the warmup. The hybrid stroke, old English backstroke had been discussed under the subtheme '*How I swim with back pain'* in study two, the subtheme '*Aquatic skills and swimming skills'* from the qualitative data from study four had noted the use of hybrid strokes had enabled the swimmers to adapt swimming for joint problems and back pain. Furthermore, the qualitative data from study four suggested that two additional hybrid strokes were helpful when adapting strokes: sculling on back with breaststroke legs and front crawl with an under-water recovery. Similar hybrid strokes have been recommended by other aquatic professionals when using swimming for rehabilitation (Dunlap 2009); these hybrid strokes could be included in future delivery of the programme. The subtheme '*Aquatic skills'* from the qualitative data from study four indicated that treading water and aqua jogging was another option for swimmers with neck and shoulder complaints;

this could be carried out with a woggle or aqua belt. It has been said that aquatic breathing is one of the most important core skills for swimmers (Newsome and Young (2012); the subthemes '*My training regime'* and '*My barriers to swimming and how I overcome them'* in study two had highlighted that gaps in aquatic breathing skills could be a barrier to swimming and that improvement in breathing skills could have a positive impact on LBP during swimming. The subtheme '*Aquatic skills'* from the qualitative data from study four suggested that some participants were able to make more rapid progress with aquatic breathing when using a nose clip; therefore, in future delivery this could be provided. The subtheme '*Aquatic skills'* from the qualitative data from study four also indicated that gliding and learning to adopt a streamline position in the water had been a valuable skill which enabled participants to make steady progress with their stroke and reduced discomfort when swimming. The data suggested that gliding in this programme should only be practised on the front or back as the side position was too difficult for most swimmers, correlating with what is known about the effect of centre of buoyancy and balance on body stability in the water (Becker 1997).

8.38 Swimming Strokes

8.38.1 Front crawl

Six activities had been suggested to enable people with CLBP learn and develop their ability to swim front crawl; new insights were observed for all activities when the data was integrated. The subtheme '*How I swim with back pain'* and '*How my back feels when I swim'* from study two supported the activities developed in study three. It has been suggested that there are several factors guiding the decision to modify or adapt a stroke including pain or lack of motor control, strength, coordination, or range of movement (Dunlap 2009). The subthemes '*Swimming skills', 'Aquatic skills', and 'Equipment'* from the qualitative data from study four reported that some swimmers adapted front crawl, using a problem-solving approach if they had restricted or painful shoulder movement to an under-water recovery. Nose clips appeared to help with the breathing control and a push off the wall into a glide helped them achieve a more streamline position when learning to swim. Participants found that practising widths of the pool initially was helpful so that they did not need to add the breathing and a 'good' swimming technique seemed to reduce LBP during swimming. Some

participants found using the hand paddles and pull buoy helped develop technique, these are common training aids used by competitive swimmer (Newsome and Young 2012). The theme '*Learning to swim with back pain*' from study two had suggested that most people with CLBP would be able to tolerate swimming front crawl. The post-programme data reported that 6-months after completion of the programme 87% of people were able to swim front crawl. Different methods of adapting front crawl were reported in study two and four, it is not known whether this was due to different swimming abilities or comorbidities.

8.38.2 Backstroke

Six activities had been suggested to enable people with CLBP learn and develop their ability to swim backstroke; new insights were observed for all activities when the data was integrated. The theme '*Learning to swim with back pain*' from study two had suggested that most people with CLBP would be able to tolerate swimming backstroke. It has been suggested that backstroke is an easier stroke to master for novice swimmers due to face being out of water (Liyanage 2020). The post-programme data, however, reported that 6-months after completion of the programme only 67% of people were able to swim backstroke to varying degrees, less than for front crawl; more support maybe required during the programme for this stroke. The subthemes '*Swimming skills', 'Aquatic skills', and 'equipment'* from the qualitative data from study four reported that all of the suggested backstroke teaching points and exercises could be included in future programmes, they were tolerated well and supported the learning and development of this stroke. The most common adaptation to swimming backstroke was the arm stroke, due to restricted shoulder movement, this was not discussed during study two, presumably due to them being a younger population with less comorbidities.

8.38.3 Breaststroke

Eight activities had been suggested to enable people with CLBP learn and develop their ability to swim breaststroke; new insights were observed for all activities when the data was integrated. In contrast to the common recommendation that people with CLBP should avoid breaststroke (Hofling et al. 2002; Liyanage, 2020, Young, 2016), the theme '*Learning to swim with back pain*' from study two suggested that some people with CLBP would be able to tolerate this stroke. It has been suggested that breaststroke is an easier stroke to master for

adult swimmers (Shaw 2006; Young 2016), the post-programme data reported that 6-months after completion of the programme 87% of people were able to swim breaststroke. The subthemes '*Swimming skills', 'Aquatic skills', and 'equipment'* from the qualitative data from study four reported that all of the suggested breaststroke teaching points and exercises could be included in future programmes, they were tolerated well and supported the learning and development of this stroke. The theme '*Learning to swim with back pain*' from study two and the subtheme '*Swimming skills'* from qualitative data from study four had suggested that developing a 'good' technique and integrating breaststroke with other strokes could improve the ability to tolerate this stroke. This correlated with the findings from one of the studies included in the scoping review which had found that stroke abnormalities either related to hyperextension in the spine or poor body balance could provoke LBP (Coleman, Persyn and Winters 2000).

8.39 Strategies to Enable People with CLBP to Become Regular Swimmers

Ten strategies to enable participants to become regular swimmers had been suggested; when the data was integrated five strategies were congruent, two were divergent and for three new insights were observed. Reflection on the wider benefits of swimming, positive feedback from instructor, signposting to adult only sessions, setting goals and making an action plan, offering a session whereby a family member or friend could join them were congruent when the data was integrated; therefore, they could be included in future delivery of the programme. The data from study one and the post-programme questionnaire in study four found that the top enablers to swimming were those which considered the wider benefits of swimming, this was also found in the subtheme '*Swimming improves my physical and mental health and functional benefits gained through swimming'* in study two and the theme '*Therapeutic effects'* in qualitative data from study four. This finding aligns with the emerging direction for future physiotherapy practice and research which focuses on the wider benefits of exercise rather than targeting specific spinal anatomy (Lewis and O'Sullivan, 2018; O'Sullivan et al. 2018).

In study one 61.7% of participants agreed that they would be more likely to go swimming if their health professional advised them to, in contrast in study four only 28.6% agreed with

this enabler. The difference in responses could be because the participants in study four had already been through the programme and been advised to swim, it was not known how many in study one had received this advice. 91% of participants in study one reported that they would prefer to attend an adult only session, the subtheme '*My swimming community*' in study two had highlighted that swimmers sometimes swam in adult only sessions, but not always; suggesting that it would be worth including the strategy of signposting to adult only sessions.

The majority of participants (76.7%) in study one agreed that setting goals and making an action plan could be an enabler to swimming whereas only 57% of participants agreed with this enablers in the post-programme questionnaire. Studies have found mixed results with regards to the effect on goal setting on exercise adherence in physiotherapy rehabilitation programmes (Bassett and Petrie, 1999; Coppack, Kristensen and Karageorghis 2012; Levack et al. 2006). The subtheme '*My goals and motivation'* from study two had suggested that goal setting enabled regular swimming and the subtheme '*Motivation and goal setting*' from the qualitative data from study four suggested that some participants were intending on using this strategy. In study four the programme did not offer a session whereby a family member or friend could attend as it was part of a research trial. The data from study one identified that 71.1% agreed that they enjoyed swimming with friends and family, and this could enable them to swim, only 57% agreed with the same enabler in the post-programme questionnaire in study four. The subtheme '*My swimming community'* from study two had discussed swimming with family and friends; supporting it as a strategy to consider in future delivery of the programme.

Making the swimming sessions fun, enjoyable and sociable and developing a peer support with others in the programme were found to be divergent strategies when the data was integrated, therefore further research may be required in this area. Enjoyment has been found to play a role in motivating some people with arthritis to exercise (Kibblewhite et al. 2017). Likewise, the subtheme '*Enjoyment'* from the qualitative data from study four reported that some participants enjoyed the fun and sociable element of the programme, but not all. The activities they enjoyed the most were the ones which are normally used when teaching children to swim; they enjoyed the challenge and laughed and smiled. 32.1% of participants in study one agreed that they didn't enjoy swimming however in study two the subtheme,

'*My feelings about swimming'* suggested that for some people swimming was enjoyable and fun. It is likely that this strategy could enable some people with CLBP become regular swimmers, but it would not be suitable for all. The subtheme '*Peer support'* from the qualitative data from study four suggested that developing a peer support group with others in the programme could enable participants to become regular swimmers, aligning with findings from systematic reviews exploring adherence in exercise referral schemes (Morgan 2016). In contrast in study one only 13.5% had agreed that they would like to make new friends through swimming. The subtheme '*My swimming community'* in study two had highlighted the value of developing a peer support group or community, particularly in the outdoor swimmers. The divergent data between study one and study two and four may reflect that people may not realise the value of peer support until they have experienced it, therefore this strategy should not be discounted.

New insights were observed for the following strategies: discounted pool fees, information about access to local pools, and further drop-in sessions. Cost has been cited as a barrier in other studies involving aquatic exercise (Fisken et al 2016). Similarly, in study one 37.8% of participant agreed that the cost of swimming could be a barrier and in the post-programme questionnaire in study four 71% of participants agreed that the cost of swimming could be a barrier. The theme '*Barriers*', subtheme '*Cost*' from the qualitative data from study four highlighted that those unable to work struggled with the cost of swimming. The population recruited in study one and four were similar, but a greater proportion reported this barrier in study four. Study four had been conducted a year later, it is not known whether the cost-of-living crisis which has developed had increase the impact of this barrier (House of Commons Library 2023). 23.5% of participants in study one agreed that a low pool temperature could be a barrier to swimming; colder pool temperatures have also been cited as a barrier to pool-based exercise in older adults and people with osteoarthritis (Fisken et al 2016; Hornsby 2016). Likewise, 57% of participants in the post-programme questionnaire data from study four reported that if the pool was too cold this would be a barrier to swimming. The integration of the data suggested that it would be worth signposting to warmer pools.

8.40 Programme Objectives, COM-B and BCW Analysis

Four programme objectives had been developed to guide the development of the swimming programme; collectively the objectives enabled swimming to be delivered as a rehabilitation modality for people with CLBP, not simply as an instructional swimming session. The objectives had been chosen based upon the logic model, the COM-B and BCW analysis, swimming and aquatic frameworks and the literature review. The integration of data from all four studies revealed congruence with these objectives and provided new insights for the COM-B model and BCW analysis. The programme objectives aligned with other functional rehabilitation approaches used with people with CLBP (O'Sullivan et al. 2018), addressing physical, psychological and social dimensions, alongside the development skills in both pain management and exercise. The swimming programme aimed to improve confidence swimming with CLBP, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for CLBP. This was addressed through the teaching and coaching approaches used to teach the core aquatic skills and swimming strokes. The programme enabled the integration of pain management skills with swimming and the recognition of barriers to swimming. This aspect of the programme was addressed before, during and after swimming sessions through the delivery of pre-programme information, the session brief and debrief. The final objective aimed to use swimming to improve function and physical activity, to consider the wider benefits of swimming beyond pain management, aiming to improve quality of life, physical and mental health, and weight management.

The COM-B analysis in the introduction chapter had not included automatic motivation, when the data was integrated it was identified the programme objectives could cover all six components from the model. Automatic motivation had been mapped on to the subthemes, '*My feelings about swimming'* and '*Swimming improves my physical and mental health and functional benefits gained through swimming'* from study two. These subthemes aligned with the second programme objective to integrate pain management skills with swimming and the fourth objective to use swimming to improve function, physical activity, quality of life and physical and mental health and weight management. The BCW analysis in the introduction had included enablement, education and training but had not considered, modelling, environmental restructuring, or persuasion as interventions for the swimming programme. Modelling refers to learning and observing others who might have similar skills or qualities, in

the case of CLBP, it could be another person with CLBP. Environmental restructuring refers to changing the social or physical context, modifying the environment to enable the behaviour, in the case of this project the behaviour was swimming, and the environment was a swimming pool. Persuasion refers to using communication to induce feelings or stimulate action to enable behaviour; this could be facilitated using logic or emotions. Modelling, persuasion, and environmental restructuring were included in two programme sections; the session debrief and strategies to enable people with CLBP become regular swimmers, which mapped onto the second, third and fourth programme objective.

8.4 Limitations

Different groups of participants were recruited, and different data was collected for each study, which could have positive and negative impacts when combining and analysing the data. The participants in study one were recruited via NHS physiotherapy and orthopaedic clinics in secondary care. They were people seeking advice and treatment for CLBP, only a quarter had been swimming during the last month at the time of completing the survey. They had a median age of 52.5 years, had experienced CLBP for median 10.5 years and 62% were female. The participants in study two were frequent swimmers who were using swimming to manage CLBP, they were not currently under the care of a health professional. They had experience CLBP for median of 25 years and 71.4% were female. The participants in study four were recruited from the same clinic as in study one, at the start of the study only one participant (4.5%) had swum during the last month. They had a median age of 56 years, experienced CLBP for a median of 10 years and 76% were female. The participants in study one and four had a similar profile in terms of median age, and median time with CLBP, however a greater proportion of people in study four were female and a greater proportion in study one had swum during the last month. There was a similar proportion of females in study two and four, however the participants in study two had experienced CLBP for a longer period, which is unsurprising as they were self-managing and not under the care of a health professional. These differences could be responsible for areas of divergence in the data, for example a swimming programme for less able swimmers with a more recent history of CLBP

may need to be delivered differently than to a group of more able swimmers with long-standing pain.

8.5 Conclusions

Stakeholder feedback and the integration and analysis of data from all four studies will be used to refine the swimming programme and direct future research. It was acknowledged in the introduction chapter that delivering a swimming programme to people with CLBP would be a complex intervention. It was also recognised that integrating qualitative and quantitative data would enable a more holistic understanding of how swimming could be delivered as a rehabilitation modality, improving usability, effectiveness, and acceptability. The qualitative research methods used in study two provided a deeper insight into the experience of swimmers who use swimming to manage CLBP, whereas the quantitative methods used in study one generated more generalisable data to understand the barriers, enablers, and preferences to swimming for this population. Study three used both qualitative and quantitative data, combining the findings from study one, two and the round one survey to develop the swimming programme, enabling the views and experience of all stakeholders to impact the development of the swimming programme. Finally study four collected quantitative and qualitative data, this data has been combined with the data from the previous studies to understand which areas of the programme should remain, be refined and where additional research may be required. The integration of data provided new insights regarding behaviours, interventions and behaviour change techniques which could be most effective when delivering the swimming and a rehabilitation modality for CLBP.

Chapter 9: Discussion

9.0 Introduction

The aim of the research project was to develop and assess the feasibility of a swimming programme as a rehabilitation modality for people with CLBP. It was acknowledged that although the research design helped address this aim, it was not the only design which could have been chosen. The research design reflected the gaps identified in the published literature, research priorities in the field of rehabilitation and CLBP, the theoretical frameworks utilised during the project and the researcher's world view and experience as a physiotherapist and swimmer. The design automatically set boundaries regarding what insights could be gained from the study data. It was recognised that the swimming programme developed during this project would not be the only way that swimming could be delivered or practised by people with CLBP and the findings from this project may not translate to other methods of using swimming. Acknowledging the benefits and drawbacks of the design choices during the study chapters has enabled the project to be transparent and will direct future research. The MRC, COM-B and BCW frameworks guided the design of the research project; therefore, this discussion chapter will be guided by these frameworks.

The chapter has been structured in the following manner. Initially, the complexity of the intervention and condition will be considered, and the findings reviewed within the core elements of the MRC framework (Campbell et el. 2000; Skivington et al. 2021). Secondly the findings are also examined within the COM-B and BCW framework (Michie, Atkins and West 2014) to understand what has been learned about the person and system level considerations during the development of this swimming programme. The limitations of the project are discussed and the unique contribution that this research project makes to the body of knowledge and evidence-based care. Finally, the impact of the research is considered, and recommendations made for future research.

9.1 MRC Framework

9.11 Complexity

The MRC framework for developing and evaluating complex interventions was chosen to guide the design of the project due to CLBP being a complex multidimensional condition and due to the recognition that rehabilitation is a complex multicomponent intervention, and there were several ways to integrate swimming (Campbell et el. 2000; Skivington et al. 2021). It was recognised during the project that CLBP is not a stable condition and is impacted week by week by biological, psychological, and social factors. This was evident during study four whereby many factors outside the control of the researcher impacted the participants, including illnesses, trauma, and caring responsibilities. In some cases, the condition could have been viewed as chaotic, leading the researcher to question whether it would be feasible to conduct interventional research. It was recognised, however that with a larger sample size that these external influences could have less impact on the research findings (Field 2009) and the opportunity for implementation could be improved by undertaking a more pragmatic study (Cumpston et al. 2021). In terms of swimming as an intervention, it was anticipated that the impact of behaviour on uptake and engagement in swimming and the range of ways that swimming could be delivered would increase the complexity when developing the programme. It was found in study one that for some enablers, such as the wider health benefits of swimming, there were high levels of agreement and for others there were a wider range of responses. Likewise in the modified Delphi study there were a wide range of views during the first-round survey however high level of agreement in the second and third round surveys for most sections of the programme. Finally, the analysis of the interviews with swimmers who use swimming to manage CLBP, identified that although there were a wide range of experiences, there were common themes, suggesting that using swimming was a complex but not chaotic experience. Based on the findings from all four studies there was sufficient evidence to support the suggestion that although complexity is on a continuum and can vary from person to person, delivering swimming to a group of people with CLBP would be considered a complex, not chaotic intervention.

9.12 Feasibility

The studies were located in the feasibility phase of the MRC framework. The following core elements from the framework will be considered: key uncertainties, stakeholders, context, and intervention refinement.

9.12.1 Key uncertainties

Several key uncertainties, relating to the recommendation of swimming, were identified in the introduction chapter, including whether any risks would be encountered when swimming with CLBP and the impact of swimming on back pain and the spine. There was also uncertainty regarding which strokes or combination of strokes to swim, whether strokes should be adapted, how often or how long to swim. The data from the observational studies in the scoping review indicated that swimming is a low-risk form of exercise but not without risk and the safety data from study four reported no serious adverse events or safety issues during the trial. The findings from the feasibility study and the integration of data from all four studies suggested that most people with CLBP were able to tolerate swimming front crawl and backstroke and some people were able to tolerate breaststroke. It is common practice for health and swimming professionals to recommend people with LBP avoid breaststroke particularly those who do not tolerate spinal extension (Hofling et al. 2002; Liyanage, 2020, Young, 2016). Observational data from study four suggested that developing swimming technique and integrating breaststroke with other strokes could improve the ability to tolerate this stroke. The findings from this project indicate that further work is required to explore the use of breaststroke by people with CLBP, recognising that it is an easier stroke to master for many recreational swimmers.

It is recognised that when compared to land-based exercise the aquatic environment provides support and enables ease of movement (Brody and Geigle 2009), this is one reason why swimming strokes can be easily adapted. The interview data from study two and observational data from study four suggested that swimming strokes can be adapted in several ways, not just for CLBP but also for other musculoskeletal conditions. Further research should be undertaken exploring common adaptations to swimming which could lessen discomfort when swimming with CLBP. Following the integration of data from all four studies it was found that there were many factors influencing how often people swim, including work

and family pressures; the findings suggested that people could manage between 30-60 minutes of swimming, building up the time incrementally. When delivering an exercise intervention, the dose is important, particularly when working with people with CLBP. The findings from this project provide some initial guidance to meeting this uncertainty.

9.12.2 Stakeholders

The stakeholders involved in this project included patients and people with CLBP, NHS physiotherapists, swimming professionals, pool operators, funders, and university academics. It is recognised that stakeholders should be involved in research at all stages, from the research design, conduct, interpretations of findings, dissemination of results and implementation (NIHR 2023). Prior to seeking ethical approval NHS patients, physiotherapists and university academics had provided feedback on the questionnaires used in the studies. People with CLBP, physiotherapists, and swimming professionals developed the swimming programme in study three, took part in the feasibility study and provided further feedback to guide refinement of the swimming programme for future research. The participants for study one and four were recruited from NHS physiotherapy and orthopaedic clinics; they would be considered direct stakeholders in that they could directly benefit from the project. The participants in study two and three were recruited via social media, they were not seeking care for CLBP but were self-managing in the community; they had been selected based upon their experience as expert patients. The other key stakeholders involved in the project were swimming professionals and physiotherapists. It was recognised that these professionals could be the ones delivering the programme in the future and they had expertise in teaching swimming, CLBP and rehabilitation, therefore it was important to involve them in the development of the programme. Academic support throughout the project ensured that the studies were conducted to a high standard and the support from the physiotherapy team enabled the recruitment of sufficient participants in study one and four. Discussing the project with local pool operators enabled access to pool time for study four and successful funding applications to professional bodies and the local NHS trust enabled the project to be fully funded. Engaging all stakeholders during this research project could improve the acceptability of the programme for service users, the usability of the programme by professionals and helped ensure that the research project could be delivered on time.

9.12.3 Context

The project was undertaken in several locations including, physiotherapy and orthopaedic clinics, via video conferencing and telephone, in person interviews and a community swimming pool. Some locations, such as clinics, would be a usual place for people to seek advice about CLBP but the study also included a community swimming pool, which was a new location for providing rehabilitation. It was recognised that different community swimming pools could have yielded different findings due to variation in set up and pool size. The choice of the pool in this study worked well for the programme, it was not known whether a different choice of pool would have generated similar findings.

9.12.4 Intervention refinement

The four studies were integrated in the meta inference chapter to guide the refinement of the different sections of the programme for future research. It was identified that additional support and sessions should be provided for less able swimmers and a greater range of times to improve access to the programme. Further research may be required to determine the teaching and coaching approaches used when delivering the programme to identify whether developing swimming technique is beneficial or whether it is more important to work on improving levels of physical activity. The analysis suggested that the session brief could be expanded to include the aims identified in the pre-programme questionnaire, more guidance on swimwear and further information on expected post swimming effects. Other motivational tools aside to setting goals and making an action plan may need to be considered in the session debrief. Some of the warmup and cool down activities could be revised based upon swimming ability and the order of the core aquatic skills section could be refined, ensuring that floating was learned after learning to glide and using nose clips to enable more rapid progress with aquatic breathing. With regard to the teaching of the strokes, the programme could focus on teaching the strokes over shorter distances, to allow later introduction of breathing and allowing a greater focus on technique to reduce discomfort and the use of hybrid strokes. It was recognised that problem-solving could be used to adapt swimming not just for CLBP but also other musculoskeletal conditions. Finally with regards to the strategies to enable regular swimming further work is required due to the number of strategies suggested for the programme. Strategies of interest could be developing swimming activities

in the programme which are fun and enjoyable, developing peer support within the group and providing further funded sessions.

9.2 COM-B and BCW Framework

9.21 COM-B Model

The COM-B model had been used throughout the project as a tool to gain an understanding of the experience of swimming with CLBP and the nature of the determinants impacting swimming uptake and engagement. In study two the subthemes were mapped onto the COM-B model; it was found that all six components of behaviour were involved when learning to swim with CLBP. In study one the barriers and enablers were also mapped onto the COM-B model; it was identified that the most common enablers to swimming utilised reflective motivation and the most common barriers were impacted by psychological capability and reflective motivation. The introduction chapter had suggested that swimming ability (physical capability) could be a barrier for many adults, however the findings from the COM-B analysis from study one suggested that although this is a factor for some it could have less impact on swimming uptake and engagement than other factors. Therefore, it was recognised that the intervention should not just include the teaching of swimming skills but incorporate techniques which target reflective motivation and increasing knowledge. In study three the different sections of the swimming programme were also mapped onto the COM-B model to ensure that all components impacting behaviour were included in the swimming programme. It is recommended that the COM-B model is used in future refinements of the programme and that the TDF is incorporated in future implementation research.

9.22 BCW Framework

The initial BCW analysis had identified that the intervention functions aligning to the research aim would include education, training, enablement, and environmental restructuring. It was suggested that education and training could be provided in the form of swimming sessions run by swimming and health professionals, aiming to increase both swimming and pain management skills. Enablement strategies would aim to reduce barriers and increase

capability and opportunities and environmental restructuring would involve changing the physical and social context when providing rehabilitation from a hydrotherapy pool in the hospital to a pool in the community. It was recognised that capability and motivation can be enhanced through training, education, and enablement and opportunity can be improved by restructuring the environment and training. The BCW analysis identified that service provision would be the most appropriate policy category. In this section of the discussion the intervention functions and policy category will be reviewed and considered in light of the project findings.

9.22.1 Education and training

The intervention functions of education and training were addressed directly through the development of a structured swimming programme which aimed to develop skills and knowledge in swimming and pain management. Initial guidance in how swimming could be delivered to people with CLBP in a group was developed in study three and the programme was evaluated as part of a feasibility study in study four. The approach utilised in this project differed to the process used to develop learn-to-swim frameworks and manuals in that the programme was developed using research methods and key stakeholders were consulted and co-produced the swimming programme. The programme taught the core aquatic skills and three of the swimming stroke, front crawl, backstroke, and breaststroke. In concordance with the national swimming frameworks (STA 2023; Swim England 2023a), the core aquatic skills provided the building blocks to learning swimming, and the teaching of the swimming strokes considered the technical aspects of swimming, stroke variability and the mind-body aspects of swimming. The programme however differed to these frameworks in that it considered whether strokes should be adapted or avoided, incorporated specific teaching and coaching approaches and integrated pain management skills such as pacing, goal setting and making an action plan. Based upon stakeholder feedback and the analysis in the meta inference chapter it was concluded that certain aspects of the swimming programme should be refined, and that further research should be undertaken before developing a full clinical trial. It was recognised that knowledge generation is not a static process but cyclical, particularly in the initial stages when there is limited understanding.

9.22.2 Enablement

Enablement strategies aim to reduce barriers and increase capability beyond the skills and knowledge developed through exercise and training. In the case of this project this referred to strategies to enable uptake and adherence to swimming. The findings from study one, two and four added to what was already known about these determinants to exercise for people with CLBP and to swimming in the general population. Different populations were recruited for each study; it was found that findings varied between populations suggesting that determinants to swimming could differ within CLBP populations. It was acknowledged that although identifying the most common barriers and enablers through surveys have value in terms of system change, due to the variability in the data it was recognised that an understanding of individual barriers could enable a tailored approach to be taken in clinical practice. It was also noted that healthcare professionals can only address some determinants and that it is also the responsibility of other stakeholders including healthcare commissioners, swimming professionals, pool operators, local government, and the national swimming bodies. The content of the programme contrasted to other programmes whereby in addition to teaching water safety and swimming skills, additional factors were considered including the time spent in the water, the frequency of the sessions, the pre-programme and within programme information and the inclusion of strategies to enable people with CLBP become regular swimmers. These additional considerations aligned with other management approaches used by physiotherapists when delivering exercise as part of a pain management or rehabilitation programme and targeted the reflective motivation and psychological capability dimensions of behaviour change.

9.22.3 Environmental restructuring

Rehabilitation programmes for people with chronic pain are usually conducted in a healthcare setting, it is now recognised that locations in a community setting may offer several advantages for this population (Hurley et al. 2022). Environmental restructuring as an intervention function in the context of this project involved changing the physical and social context when providing rehabilitation for people with CLBP from a hospital hydrotherapy pool to a community swimming pool. The findings from study four supported this community location; it was noted that some participants were able to continue swimming at the same

pool, enabling them to self-manage their CLBP. Nevertheless, several challenges were encountered including factors outside of the control of the physiotherapist and swimming teacher such as variability in pool temperature and access to pool time. It is likely that better links would need to be made with community pools operators if this programme was delivered in the future.

9.22.4 Service provision

Service provision refers to the provision and delivery of a service; and considers resources such as the facilities and stakeholders (Michie, Atkins and West 2014). The introduction chapter had discussed how the model for delivering aquatic therapy to people with CLBP is generally based upon the therapeutic model, whereas delivery and practice of swimming is based upon the educational and recreational model (Becker and Cole 1997; Lepore, Gayle and Stevens, 2007.) It had been suggested that using this uni-disciplinary model with people with CLBP could result in safety issues in the educational and recreational sector and motivational issues in the therapeutic sector which could translate to lower rates of adherence. (Dulcy 1983; Lepore, Gayle and Stevens, 2007). The programme developed during this project took a multidisciplinary collaborative approach, delivering rehabilitation and education in the community. The process used in study three confirmed that people with CLBP, swimming professionals, and physiotherapists are able to work together when developing a swimming programme, bringing different knowledge and experience to the pool. Although the study showed that there was consensus in some areas, there were other areas whereby the swimming professionals and physiotherapists disagreed. This difference in opinions would need to be recognised and addressed when delivering swimming to this population. The findings from study four suggested that in a research environment, the swimming programme could be delivered in a group setting by a swimming professional and physiotherapist in a community pool. The service delivery approach incorporated therapy with swimming education, enabling participants to use swimming for therapy and recreation on completion of the programme. Further research and refinement of the swimming programme would be required before this service could be evaluated in a larger clinical trial. Furthermore, additional work would need to be undertaken to understand the logistics of delivering this service and the financial considerations.

9.23 APEASE Criteria and Implementation

Although implementation is the final phase within the MRC framework it is recommended that this step is considered early in the development of an intervention to increase the likelihood that it can be widely adopted (Skivington et al. 2021). The introduction chapter had discussed how interventions should be designed and evaluated with consideration of the social context to increase the chance for implementation; this can be done through the APEASE criteria recommended in the COM-B and BCW framework. The acronym APEASE stands for, Affordability, Practicability, Effectiveness, Acceptability, Side effects and Equity. Affordability refers to how much the new intervention costs in comparison to existing interventions. It was recognised that a full cost analysis would need to be carried out in the future; this was outside the scope of this project. Practicability refers to whether the intervention can be implemented and what would need to be done to ensure that the intervention is sustainable. The project was only able to identify that the intervention could be delivered at one site as part of a research study. It is not known whether the intervention is sustainable; there are several factors which could have an impact including funding and the availability of pool time. Further work would need to be carried out engaging with a variety of stakeholders including commissioners, physiotherapists, swimming professionals, pool operators and people with CLBP.

Effectiveness refers to how effective and how large an effect the intervention will have; this will only be determined when a large RCT is conducted comparing the programme to another intervention. The interventional trials in the scoping review provided low-level data on the positive impact of swimming on CLBP and function and the data from study two and four suggested that therapeutic benefits could include relief and a positive impact on flexibility, physical and mental health, confidence, and function. One of the aims of the study was to improve swimming skills and confidence, on completion of the programme 88% of participants had achieved all the learning outcomes in the swimming programme, suggesting that the programme was effective in teaching swimming skills to people with CLBP.

Acceptability refers to whether the intervention is acceptable for stakeholders. Initial data from study four suggests that the intervention was acceptable, in that 93% of participants in study four reported that they felt that the programme was adapted for CLBP and 80% said

that they would recommend the programme to friends and family, with 20% being unsure as it was too soon to say. Side effects refers to considering the chances that the intervention will lead to beneficial or unintended adverse outcomes. The data from the scoping review suggested that swimming is a low-risk form of exercise but not without risk. The safety data from study four supported the suggestion that swimming was a low-risk form of exercise for people with CLBP, recording only minimal short-term side effects and two minor adverse reactions. It was acknowledged that future research in this field should continue to closely monitor side effects.

The project had originally been undertaken to reduce health inequalities with regards to access to rehabilitation in the CLBP population. The provision of the programme as a research project, reduced this health inequality in that the study was fully funded, reimbursing travel, swimming equipment, and funding the pool fees. It also enabled those who have a low-level and confidence in swimming to learn swimming and pain management skills in a pool. Sadly, there were some issues in equity outside the control of the researcher, including being limited with the times that the pool could be hired. This meant that those with work and childcare responsibilities were not always able to join the study. Future delivery of the programme should strive for greater equity in the delivery of this intervention.

In September 2023 Swim England published their latest '*Value of Swimming'* report; using the 4GLOBAL social value calculator they calculated that in 2022 swimming could have prevented 39,306 cases of back pain and 78,500 cases of illness in the UK (Swim England 2023c). The report recognised that to enable more people with long-term conditions to swim, leisure and health services should be co-located and there should be investment in building new sustainable pools. The project rationale was originally written in 2018, it was recognised that factors impacting implementation may have changed in 2023. Some changes could work in favour for the implementation of this swimming programme, for example the drive towards greater collaboration between physiotherapists and exercise professionals and the government's '*Get Active'* sport and physical activity strategy (CSP 2023; GOV.UK 2023; Swim England 2023). Other factors could present barriers to implementation such as the closure of community swimming pools, lower swimming participation rates since the COVID-19 pandemic, the cost-of-living crisis and strain on NHS finances (BMA 2023; Office for National Statistics 2023; Sport England 2023; Swim England 2021b). This project was designed to

develop a swimming programme, it has no impact on the social structure supporting people with CLBP. It is recognised that many pain management techniques can work in a research setting but in the real world due to the demands of daily life and financial strains they can be less effective. It is important that before undertaking further work that factors impacting implementation are recognised and addressed as the programme is refined, otherwise the research undertaken for this project will remain in academic journals and not impact the care and lives of people with CLBP.

9.3 Limitations

Limitations are potential weaknesses outside the control of the researcher but are recognised as having an impact on the study outcomes and conclusions and delimitations are the boundaries set by the researcher, including the scope, aims, objectives and research approach of the project (Ross and Bibler Zaidi 2019). The project was undertaken by a PhD student overseen by three academic supervisors. The research design was based upon the researcher's life experiences and worldviews as a physiotherapist and a swimmer and guided by the life experience, world views and research experience of her academic supervisors. It was acknowledged that other researchers and supervisory teams could have tackled this research problem in a different manner. To address this limitation the methodology chapter included a discussion about the beliefs and assumptions of the researcher and study two had included a section on personal, interpersonal, methodological, and contextual reflexivity. In recognition of this limitation all stakeholders were consulted, including people with CLBP to ensure that multiple viewpoints were heard.

The time period in which the studies were conducted could also be acknowledged as a limitation, particularly as in the case of this project the data was collected during the COVID-19 pandemic. During this period of time due to concerns about infection; swimming pools were closed, reopened with restrictions, closed, and then reopened. Although the data from study one and two was collected between the two periods of pool closures, there were special measures in place to reduce the risk of infection and not everyone had returned to swimming. During study three the pools had just reopened following the second lockdown and during

study four the pools were open, but people were still undergoing COVID testing and there was still a great deal of uncertainty and concern about infection. Although this presented some limitations, for example in study four one person in the study could not attend a session due to needing to self-isolate. The time period also enabled the people in study two to reflect on using swimming to manage CLBP in more depth, in that the immediate time period preceding the study people had not been allowed to swim and some had experienced negative physical, psychological, and social effects from not swimming (Swim England 2021a).

9.4 Unique Contribution

In 2017 Swim England published an independent study exploring the impact of swimming on physical, mental, and social wellbeing (Swim England 2017). The authors of the report suggested that swimming and aquatic exercise could have a significant impact in supporting the health of the general population due to the unique properties of water. The report identified that although there is a larger body of research exploring aquatic exercise, there was limited research exploring the effects of swimming on musculoskeletal health and it was recommended that further high-quality research is undertaken, due to the additional benefits of swimming on all-cause mortality and falls in older adults. This project makes a unique contribution to the body of knowledge in the field of CLBP rehabilitation and swimming in several ways. In 2022 a systematic review and meta-analysis was published investigating the effectiveness of walking, cycling, and swimming for the prevention or treatment of nonspecific LBP (Pocovi et al. 2022). The review identified only one study investigating swimming; the authors of the review suggested that health professionals discuss the results of the review with patients when developing a management plan for LBP. Although this study was of value in highlighting the limited research supporting the recommendation of swimming it only included RCTs. It was recognised that the scoping review undertaken during this project provided a broader review of the research underpinning the recommendation of swimming to people and the data extracted from the observational, biomechanical, and interventional studies could enable a more comprehensive discussion with patients (Oakes et al. 2023).

Study one was the first study to explore the barriers, enablers, and preferences to swimming for people with CLBP; the findings were used to guide the development of the swimming programme in study three. As a standalone study, it was recognised that the findings from study one could guide health professionals when prescribing swimming, swimming professionals when delivering swimming and stakeholders when providing and funding swimming activities. Since the publication of the '*Health and wellbeing benefits of swimming report*' in 2017, Swim England have been sharing testimonials whereby swimming has had a positive impact on health to promote the value of swimming (Swim England 2017; Swim England 2019). It was discovered that there had been no attempt to use research methods to

evaluate and synthesise the experiences of swimmers to identify whether there are common themes in these stories and experiences. The findings from the interviews undertaken in study two were used to guide the development of the swimming programme in study three. It was recognised that study two also had value as a stand-alone study, providing a guide for health professionals when recommending swimming to people with CLBP to facilitate a more comprehensive discussion.

Study three consulted stakeholders to develop a swimming programme to be used as a rehabilitation modality for people with CLBP, integrating the learning of swimming and pain management skills. Although there are several swimming frameworks, teaching and coaching manuals for adults wishing to learn to swim or develop swimming technique (STA 2023; Swim England 2023a); it was recognised that the current frameworks might not meet the needs of people with CLBP. Study four was the first study to evaluate the feasibility of this newly developed swimming programme and the study procedures. It was also the first interventional study evaluating swimming as a rehabilitation modality to be carried out in the UK, the first to have been jointly led by a physiotherapist and swimming professional and the first to have evaluated the ongoing use of swimming on completion of the programme, a vital outcome due to limited NHS resources. The findings from study four suggested that swimming could be delivered not just as a component but at the centre of a CLBP rehabilitation programme. The feasibility study provides sufficient evidence for the researcher to develop a funding application to refine the swimming programme and to run a larger RCT.

Over the years physiotherapists have used different forms of exercise as a rehabilitation modality for people with CLBP, including walking, Pilates, gym-based exercise, aquatic exercise, and home exercises targeting the spine and adjacent muscles. Some approaches focus on using exercise to modify symptoms and other forms of exercise, such as Pilates, aim to strengthen the core and back muscles and improve movement in the spine (Twomey and Taylor 2000). Swimming differs in several ways to many of the exercise modalities used by physiotherapists; it does not specifically focus on the spine; it has wider benefits for physical and mental health, and it could be viewed as a normal recreational exercise or sport and not rehabilitation (Dunlap 2009). Over recent years physiotherapy practice has moved away from solely focusing on the local benefits of exercise for CLBP to the wider benefits to health, recognising that physical inactivity in people with CLBP can have a negative impact on health

(O'Sullivan 2018). It was suggested in a series of papers published in the Lancet in 2018 that there needed to be a paradigm shift in the way health professionals support people with CLBP (Buchbinder et al. 2018). This project makes a unique contribution supporting this shift away from focused exercise for CLBP to a more general form of exercise that can have wider impacts on physical and mental health whilst providing a social outlet.

In the past Swim England, the national swimming body, aquatic exercise professionals and the ATACP have collaborated to develop resources to enable people to transition from receiving aquatic therapy in a hospital to practising aquatic exercise in the community. To the researcher's knowledge this project is the first whereby swimming professionals and physiotherapists have collaborated both in the development and delivery of a rehabilitation programme for people with CLBP. This initiative aligns with a recent national campaign whereby health and exercise professionals are encouraged to '*collaborate not compete'* when delivering exercise to people with long-term conditions (CSP, 2023). There is a significant burden on NHS services in the UK in 2023 (BMA 2023), the physical and mental health of people with long-term conditions can only improve if health and exercise professionals work together. This project makes a unique contribution in the move towards greater collaboration.

9.5 Impact

9.51 Research Priorities

The project topic aligned with the NHS plan for long-term conditions (NHS England 2020) and two of the CSP top ten research priorities; Priority 2 '*What methods are effective in helping people make health changes, engage with treatment or manage their health after discharge?*' and Priority 8 '*What approaches are effective for enabling people manage their own health problem?*' (CSP 2018). It was suggested in the introduction chapter that swimming could be delivered as a rehabilitation modality and used as a self-management tool for people with CLBP. The findings from study two, involving swimmers who were already using swimming as a self-management tool for CLBP, supported the suggestion that swimming could help people manage their own health problems. During the development of the swimming programme in study three, all aspects of the programme were considered to enable people with CLBP make health changes, to engage with the rehabilitation and to become life-long swimmers on completion of the programme. The data from study four found that 60% of people who took part in the swimming programme had continued to use swimming as a management tool for CLBP 6-months post programme, suggesting that swimming could be used as a method for people to manage their health after discharge. Aligning the project with the NHS plan for long-term conditions and the CSP research priorities has ensured that the research resources used for this project have been directed for optimal impact in the field of CLBP rehabilitation.

9.52 Research Excellence Framework (REF)

The REF is a tool for assessing the impact of research outside of academia; impact can refer to '*an effect on change or benefit to the economy, society, culture, public policy or services, health, the environment, or quality of life'* (UK Research and Innovation 2022). This project could have an impact within the following domains: health, quality of life and physiotherapy and exercise referral services. This project aimed to use swimming as a rehabilitation modality with CLBP, recognising the wider benefits of swimming to physical and mental health in addition to possible specific benefits to the management of CLBP. It is acknowledged that further research is required to better understand the impact that swimming as a rehabilitation modality could have on the physical and mental health and quality of life of people with CLBP.

Nevertheless, following completion of the project the following conclusions can be drawn. The findings from study two suggested that for some people with CLBP swimming can help improve physical and mental health and quality of life, however study one identified that there were many barriers which could impact uptake and engagement. Study four also found that that there were a wide range of therapeutic benefits experienced when taking part in the swimming programme, it is not known whether these benefits are comparable to those experienced in other rehabilitation programmes. Further research would be required comparing the swimming programme to current rehabilitation programmes to gather further data. With regards to the impact on physiotherapy and exercise referral services, the process used in this project enabled the development of a new rehabilitation intervention for people, which could be delivered by physiotherapists and swimming professionals in the community. Prior to this project there were no frameworks, guidelines, or service provision; the project had recognised this gap and the potential benefit for people with CLBP if it was developed.

The findings from this research project have been used to co-produce a Swim England and Versus Arthritis fact sheet for musculoskeletal (MSK) conditions (Swim England 2023b); which can be shared by health professionals with people with MSK conditions including CLBP. Feedback about the impact of this new leaflet from Andrew Power, Water Wellbeing Specialist at Swim England on the 24th of May 2023 was as follows: *'You'll be pleased to know that the MSK fact sheet has been our most popular fact sheet launch to date (with more views and downloads in the couple of weeks after launch than our Swimming before and after Surgery fact sheet launched over 8 months ago) – partly due to Versus Arthritis' promotion via a dedicated newsletter of their own'*

9.53 Dissemination

The findings from this research project have been shared at several national conferences with physiotherapists, spinal orthopaedic consultants, academics, and swimming professionals; see Table 57. The scoping review has been recently published in the *Journal of Bodywork and Movement Therapies* (Oakes et al. 2023). Over the next 9-months the researcher aims to submit the other studies for publication in physiotherapy and aquatic therapy peer review journals.

Table 57: Conferences

Date	Conference	Format	Title
2019	Physiotherapy UK	Poster	Should physiotherapists recommend swimming to patients with low back pain and is further research indicated?
2020	Physiotherapy UK	Rapid 5	Do people with long-term pain swim? Understanding participation using the active lives survey
2021	BritSpine	Poster	Pool closures during the COVID-19 pandemic and the impact on low back pain management
2021	Physiotherapy UK	Poster	Managing flare-ups: the experience of a group of swimmers with persistent low back pain
2022	Interdisciplinary research & learning conference	Poster	Strategies to help people with back pain become life-long swimmers: learning from all stakeholders through the Delphi technique
2023	BritSpine	Rapid 5	Learning to swim with back pain: A qualitative study of swimmers with chronic low back pain
2023	BritSpine	Poster	Swimming versus routine physiotherapy care as a rehabilitation modality for chronic low back pain: A feasibility study
2023	Physiotherapy Research Society	Presentation	Learning to swim with back pain: A qualitative study of swimmers with chronic low back pain
2023	Swim England Health and Wellbeing Network Event	Presentation	Learning to swim with back pain
2023	CSP Annual Conference	Rapid 5	Barriers, Enablers, and Preferences to Swimming for People with Chronic Low Back Pain
2023	CSP Annual Conference	Poster	The development of a swimming programme for people with chronic low back pain using a modified Delphi technique

9.6 Recommendations for Future Work

9.61 Patient and Public Involvement (PPI)

PPI in research refers to research which is '*done with or by the public, not to, for or about them*', PPI does not include participation in a research study (Health Research Authority 2024). It has been suggested that there are different levels of PPI with increasing levels of public empowerment: including consultation, collaboration and consumer control (Boote, Telford and Cooper 2002). There are several arguments underpinning the use of PPI in research; the epistemological argument of reducing the distance between experience and interpretation, the ethical and moral argument that the publicly funded research should actively include the public and the effectiveness argument that PPI can potentially improve the acceptability,

relevance quality and the impact of research (Boote, Baird and Beecroft 2010). The Health Research Authority (HRA) recommend four principles to enable meaningful PPI; '*involve the right people, involve enough people, involve those people enough and describe how it helps'* (Health Research Authority 2024). Six UK standards have also been proposed when conducting PPI; inclusive opportunities, working together, support and learning, impact and communications (UK Standards for Public Involvement 2019). In this project patients with CLBP were consulted during the writing of the protocol, providing feedback on the readability of the participant information sheets and the questionnaires and changes were made based upon their feedback. Furthermore, during study four swimming professionals provided feedback on the lesson plans prior to delivery of the swimming programme. These PPI activities involved the right people but on reflection more people with CLBP could have been involved and other stakeholders could have had more involvement; these PPI activities partly met the UK Standards of inclusive opportunities and working together.

When designing future studies in this field, it is recognised that PPI could improve the acceptability and experience of the research procedures, relevance and impact (Health Research Authority 2024). The first HRA principle for meaningful PPI is to involve the right people, in the case of this project people with CLBP should be at the centre of a PPI team however it would also be beneficial to include swimming professionals, physiotherapists and pool operators. The second HRA principle is to involve enough people, CLBP affects people in many different ways, therefore involving people from different backgrounds and with different levels of disability may improve the quality of the PPI. The third HRA principle is to involve people enough, therefore a collaborative approach whereby a PPI team is involved not only at the start but throughout the project, providing guidance on the study design, study conduct, analysis and interpretations of the results and dissemination of the findings to the public. For example, a PPI team could advise on the choice of data collection tools such as outcome questionnaires and study procedures logistics such as the location and timing of appointments.

It was recognised that aligning PPI activity to the UK Standards could improve the quality of the PPI and provide a tool to reflect, learn and improve PPI activity. Inclusive PPI opportunities refers to accessibility, therefore it is important that that people are reimbursed for time and travel, under-represented groups have the opportunity to take part and there is choice when

they take part. To enable inclusive opportunities future funding applications should include PPI and opportunities should be advertised in different formats. Working together relates to ensuring the purpose of the PPI has been jointly defined and documented, different methods of working together are considered and ideas, perspectives and contributions are acknowledged. Support and learning is also required for members of a PPI group, with reference to this project this could include the provision of PPI resources from the HRA website, information about the research already undertaken, and CLBP and swimming resources (Health Research Authority 2024; Pain toolkit 2024; Swim England 2024; Versus Arthritis 2024). The UK Standards recommend that there should be several different communication methods used when working with a PPI group to ensure inclusivity and improvement using PPI should be guided by impact. Communication methods should be agreed at the start of the project to ensure that it works for all member of the PPI team. The final standard states that PPI activity should adhere to the research governance standards, including data protection, transparency and effective use of time and money. This standard also aligns with the fourth HRA principle which is to be clear how PPI helps, for example how PPI in the case of this project could improve the relevance, acceptability and impact of the intervention.

9.62 Under-represented Groups in Research

To reduce inequalities in healthcare it is essential that under-represented or under-served groups are included in research. The NIHR have suggested the following demographic groups, social and economic factors and health statuses should be considered; it is recognised that these groups may be under-representative in some types of research but not all research (NIHR 2022), see Table 58

Table 58: Under-represented groups in research (NIHR 2022)

Demographic groups	Social and economic factors	Groups by health status
Age extremes (under 18 and over 75)	People in full time employment	Mental health conditions
Women of childbearing age	Socio-economic disadvantaged / unemployed/ low income	People who lack capacity to consent for themselves
Ethnic minority groups	Military veterans	Cognitive impairment
Male / female sex (depending on trial)	People in alternative residential circumstances	Learning disability
LGBTQ+/ sexual orientation	People living in remote areas	People with addictions
Educational disadvantage	Religious minorities	Pregnant women
	Carers	People with multiple health conditions
	Language barriers	Physical disabilities
	Digital exclusion / disadvantage	Visual / hearing impaired
	People who do not attend regular medical appointments	Too severely ill
	People in multiple excluded categories	Smokers
	Socially marginalised people	Obesity
	Stigmatised populations	
	Looked after children	

It was identified that several under-represented groups had taken part in this research project including people from ethnic minority groups, women of childbearing age, members of the LGBTQ+ community, people on a low income, the digital disadvantaged, people who are obese and people with multiple health and mental health conditions. Although there was some representation it was not known whether there was sufficient representation. It has been suggested that a sample is representative if it resembles the target population, for example it

is similar based upon personal characteristics and if there is sufficient representation that the results could be generalisable to the target population (Rudolph et al. 2023). One way to infer that a population is representative is to have an awareness of the proportion of people from different demographic groups in the target population and to compare it to the sample population. For example, it was identified during the project that a large percentage of the participants identified as white British, in study one 96% and in study four 86%. In Kent 83% of the population and in England and Wales 81.7% of the population identify as white (GOV.UK 2023; Kent County Council 2024), suggesting that the sample wasn't representative of the local and national ethnic minority populations. It is not known why there were lower rates however it could be related to low levels of swimming participation in the black community, in the UK it has been found that 95% of black adults do not swim (Black Swimming Association 2020). Swim England and the Black Swimming Association are involved in a research project exploring the reasons for the low levels of participation rates to enable more people in ethnic minority groups access swimming (Black Swimming Association 2024; Swim England 2022). The findings from their research could guide the choice of strategies utilised to increase representation of participants from ethnic minority groups when undertaking future research in this field.

Equality is defined as '*the state or quality of being equal'* (Dictionary.com 2024a) and equity is defined as *'the quality of being fair*' (Dictionary.com 2024b). It is recognised that both equality and equity need to be considered to enable participation of under-represented groups in research; an example from study four illustrates the difference in these two concepts. With reference to a participant on a low income, equality could refer to everyone in the study receiving reimbursement of travel at the end of the study no matter their income. To enable equity between the participants, the person on the low income could have reimbursement of travel after each visit to enable them to take part, this was one strategy employed during the feasibility study.

When planning and designing future studies in this field, it is recommended that the characteristics of the CLBP population should be better understood to ensure that there are greater levels of participation from those from under-represented populations. There is already some data available in some of the under-represented populations for example there is data concerning the proportion of male to females with CLBP, the distribution of CLBP in

different age groups and in the LGBTQ+ population (Fredriksen-Goldsen et al. 2017; Freiden et al. 2021; Wu et al. 2020). A review of the epidemiological data concerning the characteristics of the CLBP population seeking care could be carried out to better understand the population. It is recognised however that this strategy might not capture the whole CLBP population, for example people in alternative residential circumstances such as asylum seekers and the homeless, people with a language barrier and people who do not attend regular medical appointments. A review of accident and emergency attendance data coded for back pain could be reviewed to understand characteristics of people with CLBP who might not access physiotherapy services. Using current evidence and this additional data, strategies could be put in place to increase participation rates from under-represented groups. For example, to enable educational disadvantaged groups and the hearing impaired to take part, the participant information sheets could be put into alternative formats including an audio and video version and for people with language barriers there could be versions in other languages and access to translators. For people who are digitally disadvantaged there could be paper copies of information sheets and questionnaires and for people who are carers there should be the option to bring dependents to appointments. It is hoped that these strategies would enable more people in the CLBP population to shape the development of this intervention, improving the accessibility and usability and improving the generalisability of the findings.

9.63 Future Studies

The project identified many avenues for future work in this field. First and foremost, to improve equity research could be undertaken to explore additional factors impacting the uptake of swimming in the CLBP population, gaining a better understanding of health inequalities, and learning how to support and enable people who might struggle to access and participate in swimming. Further research exploring enablement could include under-represented groups in research and utilise qualitative methods, integrating the COM-B model, to explore what support or changes people with CLBP might need to overcome barriers and to gain a better understanding of enablers and preferences to swimming. It had been recognised that there were several key uncertainties when recommending swimming. Although this project has considered the uncertainties surrounding strokes, adaptation, and

swimming dose during the development and delivery of the swimming programme, further research is required to fully understand these parameters and the impact on people with CLBP. With regard to the uncertainty of the use of swimming strokes in this population, it would be of value to undertake an observational study with a similar population to the one recruited in study two, analysing stroke, adaptations, turns, warmups, and training regimes. Likewise, repeating study two with people who tried swimming and did not find it to be a helpful tool would enable a better understanding of specific barriers which could also be used to guide future development of the swimming programme.

With reference to the swimming programme further work would be required to fully assess the acceptability of the intervention and to better understand the therapeutic benefits that are important to people with CLBP, to guide the choice of outcome measures in a future clinical trial. Further research should be undertaken exploring this collaborative mode of delivering swimming in a programme, comparing it to aquatic therapy provided within the hospital and access to pool time through the exercise referral scheme. The swimming programme had included strategies to enable people to keep swimming on completion of the programme, it is not known whether these strategies were effective and due to there being no comparison group in a hospital pool it was not known whether the community location increased the number of people able to self-manage in the community, further research could explore these questions. It is hoped that the work undertaken in the research project will support a funding bid to enable further collaborative research to improve the health, function, and quality of life of people with CLBP.

Chapter 10: Conclusions

CLBP is a common but complex multidimensional condition, impacting physical and mental health, function, and quality of life. Aquatic therapy is one form of exercise provided by physiotherapists as a rehabilitation modality and swimming is often recommended to people with CLBP despite limited evidence. In the first chapter the suggestion was made that swimming could have additional practical benefits to aquatic therapy, including not requiring a specialist heated pool and therapeutic benefits targeting all three dimensions of the BPS model. Despite the proposed benefits, it was recognised that people with CLBP face barriers to swimming and there is limited data on the uptake and use of swimming in this population. Furthermore, it was identified that there were key uncertainties when recommending swimming, gaps in service provision and a lack of specific swimming frameworks, or programmes for this population. It was acknowledged that this research topic could become too large for a PhD due to the number of gaps in the field, therefore the project focused on one area, aiming to develop and assess the feasibility of a swimming programme as a rehabilitation modality for CLBP. It was recognised during this process that the findings from this project would provide some initial evidence in other areas in the field which could direct future research.

Prior to undertaking this project, a small number of interventional research studies provided low quality evidence that swimming alongside other exercise could be used as a rehabilitation modality for people with CLBP. The data collected during this series of studies contributes to a growing evidence base which could guide and support the use of swimming as a future rehabilitation modality. There are a wide range of barriers and enablers which impact swimming uptake and engagement. The findings from the survey in study one suggested that health professionals should offer the following interventions when recommending swimming; the provision of motivational tools to encourage reflective motivation, discussion of the wider benefits of swimming, specific guidance regarding the choice of swimming strokes and signposting less able swimmers to lessons. The themes developed during study two developed an in depth understanding of how people learn to swim with CLBP. The analysis found that, swimming was a valuable and effective self-management tool however learning to swim with CLBP was found to be a complex journey, impacted by several inter-related

behavioural factors. The findings suggested that some people may require access to multi-professional support, inclusive swimming communities and accessible swimming venues. Consulting key stakeholders and using the Delphi technique in study three, enabled the development of a 6-session structured swimming programme for people with CLBP, to be delivered jointly by a physiotherapist and swimming professional, teaching swimming and pain management skills including strategies to enable ongoing use of swimming on completion of the sessions. The findings from the feasibility study indicated that the swimming programme is a feasible and safe rehabilitation modality for people with CLBP, enabling physiotherapists and swimming professionals to collaboratively deliver rehabilitation and education in the community.

The analysis in the meta inference chapter supports the need for further refinement of the swimming programme. Conducting an RCT to measure outcomes, impact and cost-effectiveness compared to usual care would provide robust evidence to support the efficacy of this intervention. Additionally, further exploratory research could help identify specific subgroups of the CLBP population who could benefit from this intervention, understand the underlying mechanisms for its effectiveness and determine the most suitable context for implementation. CLBP has a significant impact on the individual and society. It is recognised that in order to provide better support for people with CLBP, new sustainable interventions should be developed which target modifiable risk factors and promote a healthy lifestyle. The findings from this project suggest that this swimming programme could be viable as a CLBP rehabilitation modality in the future.

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STA correspondence email 16/6/22

Good afternoon, Helen,

I hope you're well and thank you for your enquiry.

When we created and subsequent reviews of the International Learn to Swim Programme, we create a working group made up of industry experts, swim schools, swimming teachers etc to review the content and to test the awards scheme to ensure a smooth progression through the awards.

With the meeting we had discussions about each award / outcomes, the members of the working group then return to their swim school and test the outcomes and feedback to STA so we can make appropriate changes before the final product is launched.

I hope this helps and if you have any further questions, please do not hesitate to contact me

Many thanks

Kaylë Brightwell MCIMSPA
Head of Qualification Development

Chapter 7

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Chapter 8

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Appendix

Appendix A: Ethics Committee and Health Research Authority Approval Letters

NHS
Health Research Authority

London - Queen Square Research Ethics Committee
HRA NRES Centre Bristol
3rd floor, block B
Whitefriars
Lewins Mead
Bristol
BS1 2NT

Please note: This is the favourable opinion of the REC only and does not allow you to start your study at NHS sites in England until you receive HRA Approval

22 April 2020

Mrs Helen Oakes
Advanced Practice Physiotherapist
East Kent Hospitals University NHS Foundation Trust
William Harvey Hospital
Ashford
Kent
TN24 0LZ

Dear Mrs Oakes

Study title:	**Development of a swimming class as a rehabilitation modality for persistent low back pain: A feasibility study**
REC reference:	**20/LO/0397**
Protocol number:	**1.0**
IRAS project ID:	**264307**

Thank you for your letter of 22nd April 2020 responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

NHS
Health Research Authority

Conditions of the favourable opinion

The REC favourable opinion is subject to the following conditions being met prior to the start of the study.

Confirmation of Capacity and Capability (in England, Northern Ireland and Wales) or NHS management permission (in Scotland) should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements. Each NHS organisation must confirm through the signing of agreements and/or other documents that it has given permission for the research to proceed (except where explicitly specified otherwise).

Guidance on applying for HRA and HCRW Approval (England and Wales)/ NHS permission for research is available in the Integrated Research Application System.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of management permissions from host organisations

Registration of Clinical Trials

It is a condition of the REC favourable opinion that **all clinical trials are registered** on a publicly accessible database. For this purpose, 'clinical trials' are defined as the first four project categories in IRAS project filter question 2. Registration is a legal requirement for clinical trials of investigational medicinal products (CTIMPs), except for phase I trials in healthy volunteers (these must still register as a condition of the REC favourable opinion).

Registration should take place as early as possible and within six weeks of recruiting the first research participant at the latest. Failure to register is a breach of these approval conditions, unless a deferral has been agreed by or on behalf of the Research Ethics Committee (see here for more information on requesting a deferral:
https://www.hra.nhs.uk/planning-and-improving-research/research-planning/research-registration-research-project-identifiers/

As set out in the UK Policy Framework, research sponsors are responsible for making information about research publicly available before it starts e.g. by registering the research project on a publicly accessible register. Further guidance on registration is available at:
https://www.hra.nhs.uk/planning-and-improving-research/research-planning/transparency-responsibilities/

You should notify the REC of the registration details. We will audit these as part of the annual progress reporting process.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

After ethical review: Reporting requirements

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

NHS
Health Research Authority

Mrs Helen Oakes
Advanced Practice Physiotherapist
East Kent Hospitals University NHS Foundation Trust
William Harvey Hospital
Ashford
Kent
TN24 0LZ

Email: approvals@hra.nhs.uk
HCRW.approvals@wales.nhs.uk

24 April 2020

Dear Mrs Oakes

HRA and Health and Care Research Wales (HCRW) Approval Letter

Study title:	**Development of a swimming class as a rehabilitation modality for persistent low back pain: A feasibility study**
IRAS project ID:	**264307**
Protocol number:	**1.0**
REC reference:	**20/LO/0397**
Sponsor	**Canterbury Christ Church University**

I am pleased to confirm that **HRA and Health and Care Research Wales (HCRW) Approval** has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

Please now work with participating NHS organisations to confirm capacity and capability, in line with the instructions provided in the "Information to support study set up" section towards the end of this letter.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?
HRA and HCRW Approval does not apply to NHS/HSC organisations within Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report

(including this letter) have been sent to the coordinating centre of each participating nation. The relevant national coordinating function/s will contact you as appropriate.

Please see IRAS Help for information on working with NHS/HSC organisations in Northern Ireland and Scotland.

How should I work with participating non-NHS organisations?
HRA and HCRW Approval does not apply to non-NHS organisations. You should work with your non-NHS organisations to obtain local agreement in accordance with their procedures.

What are my notification responsibilities during the study?

The standard conditions document "*After Ethical Review – guidance for sponsors and investigators*", issued with your REC favourable opinion, gives detailed guidance on reporting expectations for studies, including:

- Registration of research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics, and is updated in the light of changes in reporting expectations or procedures.

Who should I contact for further information?
Please do not hesitate to contact me for assistance with this application. My contact details are below.

Your IRAS project ID is **264307**. Please quote this on all correspondence.

Yours sincerely,

Kathryn Murray
Approvals Specialist

Email: approvals@hra.nhs.uk

Copy to: *Professor Callum Firth, Canterbury Christ Church University*

Appendix B: Questionnaire Study One

Welcome

This survey aims to find out what stops and what encourages people with low back pain to go swimming.

Swimming pools have been closed during the coronavirus pandemic; we realise that many of your answers to this survey will be affected by the restrictions imposed by the government. Due to the changing and uncertain situation, for this survey we would like most of your answers to be related to your situation prior to the pandemic and some related to the current situation. This will be clearly indicated on the survey.

Your answers will be used to develop a specific swimming rehabilitation class for people with persistent low back pain.

Many thanks for your interest and time.

Background information; getting to know you

1. What is your age today?

2. What is your gender?

3. What is your ethnic group?

- ☐ White
- ☐ Mixed / multiple ethnic groups
- ☐ Asian / Asian British
- ☐ Black/ African / Caribbean / Black British
- ☐ Other ethnic group

7. What is your current employment status?

- ☐ Employed full time (30 or more hours per week)
- ☐ Employed part time (up to 29 hours per week)
- ☐ Unemployed and currently looking for work
- ☐ Unemployed and not currently looking for work
- ☐ Student
- ☐ Retired
- ☐ Homemaker
- ☐ Self-employed
- ☐ Unable to work

8. What is your education?

- ☐ Less than primary school
- ☐ Primary school or similar
- ☐ Secondary education / middle / high school
- ☐ University / similar
- ☐ Other

8.a. Please state if other

☐

9. What is your marital status?

- ☐ Single (never married)
- ☐ Married or in a domestic partnership
- ☐ Widowed
- ☐ Divorced
- ☐ Separated

10. In what year did you experience your first episode of back pain?

☐

11. Are you a smoker?

- [ ] Yes
- [ ] No
- [ ] Ex-smoker

Can you swim, how often do you swim and why do you go to the pool?

12. Are you able to swim?

- [ ] Yes
- [ ] No

12.a. If yes, how many lengths of a pool would you be able to swim without stopping (based on a standard 25m pool)?

- [ ] I wouldn't be able to swim 1 length
- [ ] 1 length
- [ ] 2 lengths
- [ ] 4 lengths
- [ ] 8 lengths
- [ ] More than 8 lengths

13. Have you been to a swimming lesson or coached swimming session as an adult?

- [ ] Yes
- [ ] No

13.a. If yes, did you find this lesson or coached session helpful? Please comment

14. In the last month how often have you been swimming?

- [ ] I haven't been swimming
- [ ] 1-2 times
- [ ] 3-4 times
- [ ] 5-6 times
- [ ] More than 6 times

14.a. How long ago did you last go swimming? Please comment

15. Would you like to go swimming more often?

- ☐ Yes
- ☐ No

15.a. Please comment if applicable

16. Do you go to the pool for any other reason than to swim?

- ☐ Yes
- ☐ No

16.a. Please tick a reason if applicable

- ☐ To do my hydrotherapy / aquatic therapy exercises
- ☐ I go to a water aerobics class
- ☐ I take my children / a relative / a friend swimming
- ☐ I just like relaxing in the water
- ☐ Other

16.a.i. If other, please comment

What stops you from going to a swimming pool?

Would any of the following factors **stop** you from going to a swimming pool?
Please rate on the following scale whether you strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree with the following statements.

17. It is hard for me to find the time to go swimming during the week

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

18. The cost of swimming prevents me from going swimming

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

19. It is difficult for me to get to a pool due to transport reasons (car /bus routes)

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

20. I find it hard to go swimming if I am not able to park close to the pool

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

21. I struggle getting changed due to my back pain

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

22. It is difficult for me to get from the changing room to the pool

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

23. I am worried about falling or slipping in the pool area or changing room

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

24. It is difficult for me to get in and out of the pool

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

25. I find that the swimming pool is too cold

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

Would any of the following factors **stop** you from using swimming as a form of exercise? Please rate on the following scale whether you strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree with the following statements.

26. I can't swim very well

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

27. I have a fear of water

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

28. I am worried that swimming will make my back pain worse

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

29. I have found that my back pain is worse while swimming

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

30. I have found that my back pain is worse after swimming

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

31. I am not sure which swimming stroke is best for my back pain

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

32. I don't enjoy swimming

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

33. I lack motivation to go swimming

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

34. I feel uncomfortable wearing a swimming costume or trunks

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

35. I have a medical reason that stops me swimming.

Please comment

☐

36. I have experienced an adverse reaction to swimming in a pool (for example ear problem, eye irritation, sinus problem.)
Please comment

☐

Why do you go swimming?

This section is asking about factors that might **encourage** you to go swimming. Please rate on the following scale whether you strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree with the following statements.

37. I find that I have less back pain when I am in the pool

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

38. I find that swimming eases my back pain

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

39. I believe that swimming is good for my back

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

40. I am able to do more in the water

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

41. I enjoy swimming with my friends and /or family

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

42. I like making new friends through swimming

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

43. I think that setting goals and making an action plan could help me go swimming more regularly

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

44. I am more likely to go swimming if a health professional has advised me to go

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

45. I would like to use swimming to improve my fitness and general health

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

46. I would like to use swimming to improve my mood and wellbeing

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

47. I would like to use swimming to improve my muscle strength and flexibility

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

48. I would like to use swimming to help me manage a good weight or lose weight

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

How swimming best suits you

This section is asking about additional factors that might help you choose to go to a swimming pool

49. I have found or would think that the best time of day for me to swim would be:

- ☐ Early morning (7-9am)
- ☐ Morning (9-12pm)
- ☐ Lunchtime (12-2pm)
- ☐ Afternoon (2-5pm)
- ☐ Early evening (5-7pm)
- ☐ Late evening (7-9pm)

I would prefer to swim in the following sessions

50. Adult only sessions

- ☐ Yes
- ☐ No

51. Just male or female sessions

- ☐ Yes
- ☐ No

52. A session that allows you to wear swimming t-shirt and shorts

- ☐ Yes
- ☐ No

Coronavirus pandemic and swimming

If you usually swim, what was your experience of not swimming during the pool closures (due to the pandemic), did it impact on the management of your back pain?

- ☐ Yes
- ☐ No

Please comment

Have you / did you consider trying outdoor swimming during the closure of pools during the coronavirus pandemic?

- [ ] Yes
- [ ] No

Please comment

Do you have any concerns about returning to swimming in a public pool after the coronavirus pandemic?

- [ ] Yes
- [ ] No

Please comment

Will you return to swimming in a public pool after the coronavirus pandemic?

- [ ] Yes
- [ ] No

Please comment

Final page

Thank you very much for participating in this survey.
If you have any queries, please contact me on

Appendix C: Interview Guide Study Two

Research Question	Key Concepts	Interview Questions
What is the experience of swimmers who use swimming to manage CLBP?	Experience of CLBP	Could you tell me a bit about your experience of having CLBP?
	Experience of swimming with CLBP	Did you swim before you had CLBP? Tell me about your experience of swimming since you had CLBP.
	Why they chose swimming	Why did you choose to try swimming?
	Other strategies used to manage CLBP	What else do you do to manage your CLBP?
	Modifications / adaptations to swimming	Did you have to adapt or modify your swimming stroke because of your LBP and if so, what changes did you make?
	Strokes and drills they found helpful/ unhelpful	Which swimming stroke do you find most helpful for your back? Do you use any swimming drills or other exercises in water? Do you have to avoid a swimming stroke due to your back pain and if so which one?
	Setbacks and management of setbacks	How do you manage setbacks?
	Frequency of swimming and time in water	How often do you swim and for how long?
	Motivation to keep swimming / keep active despite LBP	What has motivated you to keep swimming and keep active despite having LBP?
	Experience of swimming restrictions and CLBP during the COVID-19 pandemic	What was your experience and the impact on your CLBP during the COVID-19 pandemic swimming restrictions?

Appendix D: Round One Questionnaire Study Three

Welcome

This is the first questionnaire in a series of three questionnaires. The questions in this first questionnaire are mainly open questions; please provide as much detail in your answers as you wish. Examples from potential swimming lesson plans are included in italics for some questions. Your answers will be used to develop a specific swimming rehabilitation class for people with persistent low back pain.

Many thanks for your interest and time.

Background Information

4. Which group of experts do you belong to?

- ☐ Participant with more than 3 months experience of having low back pain
- ☐ Swimming Teacher
- ☐ Physiotherapist

Set up of swimming class

These questions are asking your views and thoughts on the best set up for a swimming class for people with persistent low back pain.

In your expert opinion....

5. How long should a swimming class last for someone with persistent low back pain?

6. How often should a swimming class be offered for someone with persistent low back pain (e.g. once a week, twice a week etc..)?

7. How many people should be in the class at the same time?

8. What time of day would it be best to hold a swimming class for someone with persistent low back pain?

Background information of the participant before starting

These questions are asking about background information of the participants, their general health, their back pain, and their swimming ability.

In your expert opinion....

9. What do we need to know about a participant's general health before the first class?

10. What do we need to know about a participant's back pain before the first class?

11. What information does a swimming teacher require about a participant's swimming ability and experience before the first lesson?

Session brief and Warmup

12. Is it helpful to discuss the session plan with the swimmers before they get in the water and what should be included in this discussion?

13. Would it be better to do a warmup on the side, in the pool or both before starting the class? (please explain reasons)

14. What should be included in the warmup?

Core aquatic skills

Core aquatic skills include learning the following: getting in and out of the pool safely, floating and balancing, turning, moving in a streamline way, breathing correctly, moving through the water and being safe while in the water.

15. Which core aquatic skills do you think are most useful for someone with back pain and why?

Swimming strokes

16. What stroke or strokes do you consider is best for back pain and why?

17. Are there any changes to the swimming strokes that you think might be helpful for someone with back pain and why?

18. Are there any swimming strokes you think should be avoided for someone with back pain and why?

19. Are there any items of pool equipment that might help someone with back pain in a swimming lesson?

Pool equipment could include floats, fins, pull buoy (a leg float), swim noodle

Cool down and session debrief

20. What should be included in the cool down section and why?

21. What would be useful to include in the session debrief after the swimming lesson and why?

Keeping going with swimming

22. In your opinion after the participant has completed the swimming classes; what might help them continue to swim on a regular basis (i.e., at least once a week)?

Any other thoughts

Do you have any other thoughts you would like to share about developing a swimming class for people with low back pain?

Thank you very much for participating in this survey
If you have any queries, please contact me on

Appendix E: Round Two Survey Study Three

Welcome

This is the second questionnaire in a series of three questionnaires. Thank you for completing the first-round questionnaire; I learned a great deal from reading your responses.

This second questionnaire has been developed based upon your answers and from what I learned from the previous 2 studies. I apologise that the questionnaire is longer than the last one; I would estimate that it will take 20 minutes to complete.

This questionnaire only has closed answers as the purpose is to achieve an agreement in the group (those involved in this survey) as to how a swimming class could look and be delivered for people with persistent low back pain. Although I refer to the condition as back pain in the questionnaire, it is recognised that the condition known as persistent low back pain is not just experienced as a pain. Physically people with back pain often have less mobility in their spine, some people can become fearful of movement, their spine can feel compressed, they may have weakness of their core, leg and arm muscles and suffer from fatigue. Back pain can also have a social impact and can affect someone's mental health. With this in mind I would like you to consider all aspects of persistent back pain when completing this survey.

The questions ask for you to strongly agree, agree, disagree, or strongly disagree with each proposal and there is also an unsure option and a box for comments, which are optional.

Many thanks for your interest and time.

Background Information

1. Which group of experts do you belong to?

- ☐ Participant with more than 3 months experience of having low back pain
- ☐ Swimming Teacher
- ☐ Physiotherapist

Set up of swimming class

These questions are asking whether you agree with this proposed set up for a swimming class for people with back pain.

The participants in the survey felt that the length of the swimming class would vary depending on the individual, but the average time offered would be **30 minutes**.
Do you agree that this length of class is suitable for someone with back pain?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Further feedback from survey:

Estimates of how long to run the class ranged from 15 minutes to 60 minutes.

When deciding how long to spend in the pool for the initial class you could take into account the person, condition, severity, cause of pain, mobility, swimming skills, ability and history, age, water temperature, how long they take to warm up and whether they exercise regularly or are physically active.

It was felt that you would start with lower time and build up. Building up the time in the water could be based upon the persons response, confidence, improvement, and strength.

There was recognition that people with persistent low back pain can have reduced exercise tolerance and fatigue quicker.

The participants in the survey felt that the frequency this swimming class would be offered, would vary depending on the individual, but the average frequency offered would be **once to twice a week**.

Do you agree that the frequency of the class is suitable for someone with back pain?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Further feedback from survey:

Estimates varied between 1 and 4 times a week, twice a week was the average starting point for how often a class should be offered.

Points raised included the importance of having a few days break between the class and building up the number of sessions. One person felt that a large gap between sessions (more than 2/3 days) would be detrimental as swimming techniques needs to become habitual.

Barriers such as cost of session were mentioned. Attending a class once a week might be a good to starting point, so it is easier to commit to sessions.

The frequency of the session would depend upon the pain

The swimmers would be encouraged to work out what frequency was best for them.

Again, the participants in the survey felt that the number of people in the class would vary and be dependent on many different factors, but the average number in the class would be **five people**.

Do you agree that learning swimming in this group size would be suitable for people with back pain?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Further feedback from survey:

Again, there were several factors to consider with the size of the class

Estimates ranged from 1 to 12. The average response for the size of the class was 5.

Points raised included health and safety, if the back pain is easily flared up then no more than two people in the class. A smaller class size was suggested to help monitor pacing and symptoms. Also, the size class depends on the number of teachers and lifeguards. For more confident people a large number in the class is acceptable. Larger classes have benefits of more social interaction, support, and peer learning. If the class is mixed ability a lower number of swimmers may be better.

Body confidence and awareness of the person may also dictate how many are in the class. So, if they have done other forms of exercise, such as Pilates or Yoga then they may require less instruction than someone who is new to exercise.

A 1:1 class allows for the teacher to assist the swimmer, if required and to demonstrate.

The participants in the survey gave a wide range of answers to this question, however, based upon the responses the swimming class will be offered **at different times during the day except for early morning and late in the evening**.

Do you agree that these times would be best for someone with back pain?

- [ ] Strongly agree
- [ ] Agree
- [ ] Disagree
- [ ] Strongly disagree
- [ ] Unsure

Further feedback from survey:

There were a wide range of responses to this question. It would depend on the individual and other commitments such as work and family.

The people with low back pain felt that first thing in the morning was not the best time, it takes time to get moving. Late morning or early afternoon would be best but also a time outside normal working hours should be offered. It is important to offer a range of times.

One swimming teacher / coach felt that offering an early morning slot might help improve the mobility for the next few hours. Equally timing the session with when the participant struggles with pain, poor mobility, and muscle tension might enable them to get some relief for the rest of the day.

Any comments about set up of swimming class? (optional)

Pre-class information

The participants in the survey suggested two different standardised forms that could be used to screen **general health** prior to starting the swimming class; the aquatic therapy screening form and the PAR Q questionnaire. Additional questions were also suggested.

Please see aquatic therapy screening form below, do you agree that this is a suitable general health checklist to use prior to starting a swimming class for someone with back pain? (This form is the usual form used prior to aquatic therapy sessions at the hospital)

- [ ] Strongly agree
- [ ] Agree
- [ ] Disagree
- [ ] Strongly disagree
- [ ] Unsure

Aquatic therapy screening form
Cardiovascular
Absolute contraindications: Left ventricular failure, resting angina, recent deep vein thrombosis, recent pulmonary embolism, blood clotting disorder, unstable INR, aneurysm, recent stroke, recent heart attack, recent heart surgery
Relative precaution: Angina on exertion, pacemaker, high or low blood pressure

Skin
Absolute contraindication: Infected wound, skin, or fungal infection
Relative precaution: Open / healing wound, Poor skin integrity, invasive tube in-situ, sensitive to chlorine, verruca / wart
Respiratory
Absolute contraindication: Short of breath at rest, chest infection
Relative precaution: Short of breath on exertion, reduced thoracic expansion
Other
Absolute contraindication: Renal failure, recent organ surgery, uncontrolled incontinence, diarrhoea / vomiting in last 48 hours, receiving radiotherapy
Relative precaution: Diabetes, fear of water, controlled incontinence, epilepsy, osteoporosis, impaired vision, hearing aids / grommets, history of fainting, MRSA, or other infections

Please see physical activity readiness (PAR Q) questionnaire below, do you agree that this is suitable general health checklist to use prior to starting a swimming class for someone with back pain? (This questionnaire is often used by exercise professionals)

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Physical activity readiness questionnaire (PAR Q) (short version)

Has your doctor ever said you have a heart condition and that you should only do physical activity recommended by a doctor?

Do you feel pain in your chest when you do physical activity?

In the past month, have you had a chest pain when you were not doing physical activity?

Do you lose balance because of dizziness, or do you ever lose consciousness?

Do you have a bone or joint problem (for example back, knee or hip) that could be made worse by a change in your physical activity?

Is your doctor currently prescribing medication for your blood pressure or heart condition?

Do you know of any other reason why you should not take part in physical activity?

Please see list of additional points that could be asked about general health below, do you agree that it would be beneficial to include these additional questions?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree

☐ Unsure

Additional points that could be asked about general health which were raised by the participants in the survey included the following:
Drug / medication list including medication such as an inhaler that might need to be used during the class and would be kept on side?
Mobility impairment, can they get from the changing room to the pool, in and out of the pool unaided?
Will they need to use the hoist or a walking aid?
Are they worried about falling or slipping in the pool area or changing room, if so, what can we do to help?
Do they have a foot drop or neuropathy?
Hearing or visual impairments?
Phobias or concerns?
Do they suffer from fatigue?
Do they already exercise / are they physically active?
Do they have any specific problems that might cause a problem in the water or a problem with swimming?
If the swimming teacher or coach is unsure that the person is safe to start swimming, they could consult their GP or Physiotherapist
What do we need to know about the participant's back pain before their first swimming class? Please see questions below, do you agree that these are suitable questions to ask? (The participant would also undergo a standard physiotherapy assessment prior to the class.)

☐ Strongly agree
☐ Agree
☐ Disagree
☐ Strongly disagree
☐ Unsure

Questions about back pain

Diagnosis / cause of back pain?

Further information about your back pain; how long have you had it, location of pain, type of pain and intensity.

What makes your back pain better and what makes it worse?

How easy is it to provoke or increase your back pain (irritability), do you get frequent flare ups?

How mobile is your back? Which movements are restricted (back, legs and arms)?

What have you tried already; did it help?

What did your health professional recommend? Have you received any advice about being cautious about certain activities?

Are you someone who tends to avoid or push too hard with exercise?

How is your back after exercise?

What are your aims and goals attending this swimming class, e.g., to reduce pain, improve fitness, manage a healthy weight?

What are your expectations of swimming and how does this fit with these aims and goals?

What do we need to know about the participant's swimming ability and experience before their first swimming class? Please see checklist below, do you agree that this is a suitable checklist?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Swimming ability and experience
(One length of a pool is usually 25 metres)

Can you swim aided? (yes/no)

How far could you swim without stopping? (in metres)
What is your preferred stroke for your back?

Can you swim front crawl? (yes/no)

Can you swim backstroke? (yes/no)

Can you swim breaststroke? (yes/no)

Do you swim any other stroke? If so which stroke?

Are you comfortable in deep water and can you tread water? (yes/no)

Can you put your face in the water and breathe out? (yes/no)

Would you normally use goggles to swim? (yes/no)

Can you enter and exit the water without assistance? If you can't what help will you require? (yes/no)

Can you float unaided? (yes/no)

Do you have any phobias or worries about swimming or being in water, have you ever had a bad experience in water? (yes/no/ please comment)

When was the last time you swam?

How often have you swum in the last few months?

Have you had swimming lessons as an adult?

How do you feel in warmer and colder water, what temperature is best for you?

It was mentioned that a practical assessment of swimming ability would also be useful along with some information about what to bring when they come to the class and what to wear. This might include what to wear if they feel uncomfortable in a swimming costume or trunks e.g., they could wear a rash vest, bring a towel on the side.

Any comments about pre-class information? (optional)

Teaching approach

There are different methods of teaching and coaching swimming and different approaches to rehabilitation. Which of the following methods or approaches do you agree would be suitable for someone with back pain in a swimming class?

It is recognised that people have different learning styles, and all these styles of learning might be appropriate. The reason for asking this question is that I would like to know which method(s) might work best for someone with back pain.

An instructional approach whereby a set lesson plan is delivered to a group of swimmers

- Strongly agree
- Agree
- Disagree
- Strongly disagree
- Unsure

A constructivist approach whereby the swimmer actively constructs what they learn, they problem solve, and the teacher facilitates the learning experience

- Strongly agree
- Agree
- Disagree
- Strongly disagree
- Unsure

A technical approach aiming at improving swimming technique

- Strongly agree

- [ ] Agree
- [ ] Disagree
- [ ] Strongly disagree
- [ ] Unsure

A visual approach including demonstrations and video feedback

- [ ] Strongly agree
- [ ] Agree
- [ ] Disagree
- [ ] Strongly disagree
- [ ] Unsure

A kinaesthetic approach whereby participants consider how their body feels when they are swimming and make changes to their stroke based upon how they feel

- [ ] Strongly agree
- [ ] Agree
- [ ] Disagree
- [ ] Strongly disagree
- [ ] Unsure

An approach that takes into account the different types of back pain, that may respond to differently to different swimming strokes and programs

- [ ] Strongly agree
- [ ] Agree
- [ ] Disagree
- [ ] Strongly disagree
- [ ] Unsure

An approach that focuses on swimming as a form of exercise and training, encouraging swimmers to monitor progress and set goals

- [ ] Strongly agree
- [ ] Agree
- [ ] Disagree
- [ ] Strongly disagree
- [ ] Unsure

An approach that focuses on swimming being used to increase levels of physical activity, making swimming fun with less focus on swimming as a form of exercise and less concern about technique.

- [ ] Strongly agree
- [ ] Agree
- [ ] Disagree
- [ ] Strongly disagree
- [ ] Unsure

Any comments about teaching approach? (optional)

Who would lead the class?

Different people could take the swimming class, do you agree that the following person(s) could lead the class? (Please note that the participant in the class would have had a physiotherapy assessment prior to starting the class.)

A Physiotherapist trained in aquatic therapy.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

A level 2 swimming teacher or coach with experience teaching adults.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

A collaboration by which both a physiotherapist and swimming teacher or coach lead the class.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

A collaboration by which a person with low back pain who has already completed the class joins the swimming teacher / coach or physiotherapist leading the class.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Any comments about who could lead the swimming class? (optional)

Session brief

The participants in the survey agreed that a session brief would be beneficial, however it should not be too long. There was concern about where this briefing could be done and not using up some of the time that could be spent in the pool.

It is assumed that the following would be included prior to any swimming class; safety information, housekeeping, water temperature, depth, safety procedures, register changes in

health, back pain, and wellbeing, are they well hydrated and when did they last eat. How to enter and exit water and summon help. Introduction to the type of session, session plan, which strokes, aims, objectives and the time the session will run.

Do you agree the following additional items should also be included in a session brief before the swimming class?

Explain why using **swimming as a rehabilitation tool**, the benefits, and problems with this type of approach and any guidelines. Include some discussion about not knowing which swimming stroke is best for back pain. Hopefully by the end of the class the swimmers will have developed a better understanding of what stroke(s) are best for their back. Also talk about the wider benefits of swimming such as impact on weight and mental health and how this could help in the management of their back pain.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Discuss any **concerns, fears, and barriers**; in relation to back pain, swimming or being in the water

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Discuss **what to expect** and what is normal during and after a swim. They might experience some discomfort, mild shortness of breath and muscle fatigue; they should alert the teacher if they experience a significant increase in back pain or they feel unwell. Discuss pacing and when they should rest /pause between activities or lengths. Discuss their expectations; what do they want to achieve from the session

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Any comments about session brief? (optional)

Warmup

The majority of people in this survey felt that a water based warm up was better than a dryland warm up.

There are examples of water based warm up activities below. Do you agree that the following **warm up activities aimed at improving the experience of swimming with back pain** could be included in a class?
(Please note that not all aspects of this warmup would be included in each session, just one or two activities)

Start with easy / low intensity swimming (front crawl and backstroke), gradually increasing intensity. Finding out whether it is better for them to warm up alternating strokes or with just one stroke.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Walking in the water, different directions, different speeds, with or without floatation aids, walking while doing sculling movements with arms.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Light jogging in the water

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Stretches in the water for back, neck, arms, and legs, including usual physio stretches. Finding out whether it is better for back to do stretches when they first get in pool or after some low intensity swimming.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree

- ☐ Strongly disagree
- ☐ Unsure

Awareness activities including getting used to the sensation of the water and the feeling of weightlessness, how does this impact on movement and breathing. Feeling the sensation of their spine lengthening when moving through water. Bringing an awareness to their breathing using techniques and exercises. Acclimatisation to the water temperature, if the session is in different settings feeling what water temperature is best for their back.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Relaxation, floating and sculling

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Further information from survey:

One person in the survey felt that that they would prefer to get in straightway, particularly if they were a little anxious about the session. It was suggested that a dryland warm up on the poolside might be embarrassing for those who are not body confident, adding to stigma. Safety issues were highlighted with regards to risk of tripping, particularly for those with mobility issues. Worry about slips and falls was also highlighted as a barrier to swimming for people with back pain in my previous study.

There was a question about lack of evidence supporting warmups before swimming.

Swimming teachers/ coaches were less confident with dryland warmups for this group due to restricted medical knowledge. A dryland warm up however using their own exercises could give the teacher an indication of the level of pain.

Warming up in the water was assumed to better as the weight of the body would be supported in the water, there would be less pressure, the water would provide resistance and it would support movement.

A water based warm up allows the swimmer to get used to the feel, temperature, and smell of the water.

If a dryland warmup was advised, then it could be done in the gym or at home before arriving at the pool.

Any comments about warm up? *(optional)*

Core aquatic skills

The participants in this survey agreed that the choice of aquatic skills would need to be specific to the swimmer and would depend upon the experience and ability of the swimmer and their aims and goals.

It is assumed that core aquatic skills would be used in any swimming class therefore I have included some examples of how the skills might be adapted for someone with back pain.

Do you agree that the following **core aquatic skills aimed at improving the experience of swimming with back pain** below could be included in a class?

Water safety, how to enter and exit the water, learning to make adjustments, trying different methods to reduce discomfort or accommodate for back pain, loss of strength and mobility. This could include using steps, sliding in, using ramps or hoists.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Breathing exercises with head out and in the water, mindful breathing, compare breathing out through mouth and nose, compare different speeds of inhalation and exhalation. Develop an awareness of how body feels with different styles of breathing, discover which variation feels more comfortable for back and breathing. Discuss concerns about putting face in water such as feeling claustrophobic. Learning how to fit and wear goggles so able to relax when breathing in water. Learn how breathing exercises can be used to manage anxiety, pain, and focus on the present moment.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning to float, trying different head, body, arm, and leg positions in water, feeling which ones are more comfortable for their back. Learning to relax while floating in the water.

Learning how to stretch whilst floating. Using floating to increase core strength. Using floating to deal with panic in the water or if experiencing cramp. Using equipment to support body whilst floating.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning to glide and move in a streamline way, trying different head, body, arm, and leg positions in the water, feeling which ones are more comfortable for back and which improve the efficiency of the movement through the water.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning to change position in water (e.g., from front to back), using the core muscles during these transitions and relaxing the spine to allow it to move freely. Being aware how this feels different in the water when compared to being on dryland. Practicing different ways of turning at end of length, finding out which feels more comfortable. If nerve damage affecting one leg, then look at how could modify push off wall.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning how to cope with a painful episode when swimming, being able to indicate when they need support. Being able to get to the side or shallow water independently.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning how to tread water and jog in deep water with a float, trying different arm and leg movements, feeling which movements are more comfortable for back.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Developing a **feel for the water** with hands through sculling, feeling how core muscles are recruited with this movement, trying sculling in different positions (on back, on front and vertical).

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Awareness exercise: do they feel more confident moving in the water than on land, can they do more in the water, do they have less fear of movement, does their back feel different in the water, do they have less back pain in the water, do their muscles feel more relaxed in the water, do they feel that the water is providing support for their back? Trying different movements that they struggle with on land in the water, if this movement feels easier, practising it in water. Learning to be in the present moment during swim.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Trying hybrid strokes if standard strokes do not agree with them, looking at different combinations of arm propulsion, kick, and body positions, which combination feels best for them. This could be considered if issues with other joints, such as shoulders or knees

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Any comments about core aquatic skills? *(optional)*

Swimming strokes: Front crawl teaching points and drills / exercises

Most of the participants in this survey thought that swimming front crawl would be beneficial for someone with back pain. Do you agree that the following teaching points and drills/exercises **aimed at improving the experience of swimming front crawl with back pain** below could be included in a class?

Learning to swim front crawl with **head looking straight down**, not forwards to relax neck and back muscles and not extend lumbar spine

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning to swim front crawl with lower **body position** in the water, at an angle rather than in line with the water surface; lifting the back and dropping the legs in the water so that lumbar spine is in less extension / neutral position. Optional use of equipment such as noodles under trunk to support swimmer in this position.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning how to adopt a more **streamline position** in the water for their body so that less effort required to swim, adding a pull buoy or flotation trunks if required so swimming close to surface.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Improving rotation of the trunk so that the whole body rotates, learning to breathe both sides if possible. Learning to move smoothly through water using this rotation. Drills to enhance rotation could include 6 kicks and roll and a single-arm drill. Do they feel better using front crawl to improve the rotation in spine or is it more comfortable to rotate the whole body?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Being mindful to exhale in the water and to inhale the normal amount of air, not hyperventilate. Practising different intervals when taking a breath. Compare breathing through mouth and nose. Practise different speeds of inhalation and exhalation. Compare different head positions when taking breath to the side. Discover which variation feels more comfortable for back and for breathing.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Increasing the feeling of **lengthening** in the spine whilst swimming with stronger pull and not 'over kicking', The following drills could be used; arms only with pull buoy, catchup, focusing on extending the arm in front before the next stroke, trying different kick beats (6,4,2) and feeling difference with back.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

If unable to use legs whilst swimming (e.g., due to nerve damage) finding ways to swim and keep in a streamline position either with floats, using core or increasing speed. If nerve damage only affecting one leg, find out whether better for back to use just one leg or no legs.

Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back (**a problem-solving approach**)

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Any comments about front crawl teaching points and drills / exercises? *(optional)*

Swimming strokes: Backstroke teaching points and drills / exercises

Most of the participants in this survey thought that swimming backstroke would be beneficial for someone with back pain. Do you agree that the following teaching points and drills/exercises **aimed at improving the experience of swimming backstroke with back pain** below could be included in a class?

Learning to swim backstroke with **head looking up**, not down the pool to relax neck muscles and to reduce sinking of legs, being aware how head position changes low back position whilst swimming. Learning to follow ceiling or if outside shore or bank to reduce disorientation in this position and to keep swimming course straight.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning to swim backstroke with **body on the surface of the water** and a slight angle downwards with legs, but not allowing legs to sink too much so less extension in lower back. Feeling that movement through water in this position is more streamline and less effort is required. Drills include kicking with the noodle underarms, kicking on back hugging float, using small pull buoy, wearing floatation trunks.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning how to improve rotation of body during backstroke. Being aware how this could increase the feeling of lengthening in spine and improve the efficiency of the arm pull. Do they feel better using back stroke to improve the rotation in the spine or is it more comfortable to rotate the whole body? Using this rotation to move smoothly through water. Drills: single arm pull, not over kicking, kick only to keep legs in correct position in water

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Being mindful to exhale through nose so water does not enter nose whilst on back and to inhale the normal amount of air, not hyperventilate. Practising different intervals when taking

breath with stroke. Practise different speeds of inhalation and exhalation. Discover which variation feels more comfortable for back and for breathing.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning how to use the flags when swimming backstroke so able to judge how close to the end and therefore allowing the swimmer to stay on their back and relax when swimming this stroke.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning alternative ways to swim on the back such as old English backstroke (breaststroke kick and double arm pull) or sculling with breaststroke or flutter kick, being aware how back feels with different versions of stroke.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back (**a problem-solving approach**)

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Any comments about backstroke teaching points and drills/ exercises? *(optional)*

☐

Swimming strokes: Breaststroke teaching points and drills / exercises

Some of the participants in this survey thought that breaststroke would be beneficial for someone with back pain. Do you agree that the following teaching points and

drills/exercises **aimed at improving the experience of swimming breaststroke with back pain** below could be included in a class?

Learning flatter breaststroke with slower stroke turnover (less ballistic), longer glide and wedge kick (the older style of swimming breaststroke). Being aware of the feeling of lengthening through spine during glide phase.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Practising different head positions during the stroke cycle, allowing the head to dip to relax neck muscles when face in the water, feeling how different positions effect their neck and back.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Trying breaststroke with **more and less undulation**. Do they feel better using more undulation to mobilise the lumbar spine or less undulation?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Being mindful to exhale in the water and to inhale the normal amount of air, not hyperventilate. Practising different lengths of glide, which will affect intervals when taking a breath and different speeds with stroke transitions (e.g., from pull to glide). Compare breathing through mouth and nose. Practise different speeds of inhalation and exhalation. Discover which variation feels more comfortable for back and for breathing.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Trying different ratios of kick and pull, e.g., two kicks to one pull so longer period when flatter in water, feel the difference with different ratios on back.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Learning how to do breaststroke kick on back, with sculling arms or double arm pull (old English backstroke), feeling how this change in position affects their back, is there less lumbar extension? Use this position on back to improve awareness and develop breaststroke kick. Use noodle if requires support initially. Alternately stroke on front and back, if back better changing position more frequently.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Experiencing swimming breaststroke under the water for example trying the drill; 3 kicks above water, 3 kicks below the water or breaststroke legs only under water. Being aware of feeling of weightlessness under underwater and lengthening of spine.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back (**a problem-solving approach**)

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Any comments about breaststroke teaching points and drills/ exercises? *(optional)*

Cool down

The participants in the survey suggested a number of cool down activities, some of the suggestions were similar to the warmup activities.
There are examples of cool down activities below. Do you agree that the following **cool down activities** aimed at improving the experience of swimming with back pain could be included in a class?
(Please note that not all aspects of this cool down would be included in each session, just one or two activities)
Easy / low intensity swimming. Changing the stroke from the main set, e.g., if swam on front then would cool down on back.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Old English backstroke (on back double arm with breaststroke kick)

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Gentle stretches in the water, specific stretches advised by physiotherapist. Do they have more movement now, does the movement feel easier compared to the start of the session?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Sculling on back with or without breaststroke kick and just kicking. Breathing, relaxation, floating on back, meditation type breathing exercises.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Walking in water and gentle movements with a fun element

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Any comments about cool down? *(optional)*

Session debrief

The participants in this survey made a number of suggestions of what could be included in the session debrief after the swimming class. Do you agree that these ideas would be suitable for someone with back pain?

Reflection on class, general feedback from swimmer. What they expected versus what they achieved during session? How it felt, was any of the session uncomfortable for their back, do they have any concerns? What went well, what did they enjoy, what was more challenging, what did they dislike? What stroke(s) were best for their back in this session? How are they feeling physically and psychologically? Relate to key values or goals.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

What to work on before the next session? Goals for the following week? Motivational tools they could consider? What will be covered in the next session. Dryland exercises they could try this week. Do they need any equipment next week?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Cover any teaching / coaching points that were difficult to communicate while they were in the water or as a group. What could they adjust or adapt in the next session.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Explain how the person might feel afterwards and how to deal with it. Flare up of pain, advice / reassurance, and safety netting.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Positive feedback from teacher / coach. Finish with a reflection on achievements, not problems.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Any comments about session debrief? *(optional)*

☐

Keep going with swimming

The participants in the survey suggested a number of strategies that might encourage people to continue swimming after they have completed the swimming class.

Which of the following strategies do you agree are helpful in encouraging people with back pain to continue to swim?

Developing a peer support group with others in the class, using social media such as WhatsApp or Facebook.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Email or text prompts to remind them to book a swim session.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Subsidised / discounted access to pool

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Setting goals, being comfortable prioritising self so able to swim regularly and making a written action plan before the last session.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Signing up for a challenge or an event to work towards for example the Swimathon challenge. If not entered an event before, discussing what to expect, so able to enter 'that world', if not from a sporty background. Monitoring swims with an App such as Strava.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Time to reflect on other benefits of swimming, beyond their back pain, such as improvements in fitness, general health, wellbeing, mood, general muscle strength and flexibility, and being better able to manage a healthy weight. Use these benefits as an additional motivational tool.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Integration with regular classes in local pool

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Making the swimming sessions fun, enjoyable and sociable.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Offering a session whereby a partner, family member or friend can join them in the water

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Signposting to sessions for only adults and for just women or just men.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Further drop-in sessions at pool

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Information about access to local pools and cost. Information about changing facilities. Discuss about taking time to prepare to get in the water and to leave the venue. Information about outdoor swimming sessions with further information about safety.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Encouragement and positive feedback from person leading the class, highlighting improvements since swimming. Time to reflect on benefits for back pain and general health.

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Paperwork to support what they have learned during the class

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Any comments about keeping going with swimming? *(optional)*

Do you have any other thoughts you would like to share about developing a swimming class for people with low back pain?

Thank you very much for participating in this survey.

If you have any queries, please contact me on

Appendix F: Round Three Survey Study Three

Welcome

This is the third questionnaire in a series of three questionnaires. Thank you for completing the first and second round.

This third questionnaire has been developed based upon your answers to the second questionnaire. The responses to the closed questions have been grouped and I have read your comments and made several changes. I have calculated the percentage level agreement, the average (mean) response from the group and standard deviation. The items in the survey that achieved a 70% level agreement or greater will be included in the initial class. The responses have been ranked for level of importance using the average (mean) response calculation. Responses that have had greater than < 1.0 standard deviation will be reviewed again by the group, even if there is greater than 70% agreement as this calculation indicates that there is a wider range of responses within the group.

I have also read your comments, these have been very helpful and have guided the development of this third questionnaire. I developed the second questionnaire based upon the answers from the first questionnaire and also from what I learned from study 1 (current NHS patients with back pain) and study 2 (people who use swimming as a tool to manage back pain). I realise that some of the ideas that were suggested in the second questionnaire for a swimming class do not align with current rehabilitation guidelines, but I did not want to ignore what the people who use swimming to manage back pain were telling me. Best practice and guidelines should be challenged and reviewed on a regular basis and this type of exploratory research aims to reflect on current practice and improve what we offer.

This final questionnaire presents the consensus within this group with regard to a swimming class that could be tested in a clinical trial for people with persistent low back pain. Initially the class will be tested in a small-scale feasibility study and further feedback will be gained from the people in this trial and the people taking the class. I would imagine at that stage further changes will be made to the class. If the results are favourable, then the class will be tested in a larger trial against the usual treatment we provide in the NHS.

One suggestion at the end of the survey, was to be clear about the emphasis for the class and what it is trying to achieve. The class will be used as a form of rehabilitation for people with persistent low back pain. The class will provide participants an opportunity to learn to swim and improve their swimming ability making adaptations, if required, for their back condition. As this is a long-term condition hopefully, they would keep swimming on a regular basis after the class. It is hoped that the participants would become more competent swimmers and through the class develop skills to better manage their condition. Hopefully by using swimming this can be done in a less clinical manner; the process should be fun, empowering and challenging; learning what they can do despite having back pain and becoming more active in the process.

The questions in this survey mostly ask for comments but also there are a few sections which ask for you to strongly agree, agree, disagree, or strongly disagree with each proposal and there is also an unsure option. Many thanks for your interest and time.

Background Information

Which group of experts do you belong to?

- ☐ Participant with more than 3 months experience of having low back pain
- ☐ Swimming Teacher
- ☐ Physiotherapist

Set up of swimming class

There was **at least 70% level of agreement** in the group that the average length of swimming class could be 30 minutes, the class could be offered between once or twice a week and the average number of people could be 5 people in the class.
There was **less than 70% agreement** on the time of day that the class could be offered.

	Ranking (mean)	Set up of swimming class	% Agreement	Standard dev
1	1.73	Frequency of class (1-2 wk)	100%	0.46
2	1.8	Length of class (30 mins)	93.33%	0.56
3	2.26	Group size (5)	73.33%	0.8
4	2.4	Time of day	66.67%	1.12

The participants in the survey commented how the best time of day will vary from person to person, therefore it would be best to offer a range of times.

Based upon the answers and comments in this survey initially the average length of swimming class would be 30 minutes, the class would be offered between once or twice a week and the average number of people would be 5 people in the class; there would be a range of times that the class would be offered. Do you have any comments about trialling this set up of swimming class? *(optional)*

Pre-class information

There was **at least 70% level of agreement** in the group that either the aquatic therapy screening form or the PAR Q questionnaire could be used to screen general health, with additional questions. There was also agreement in the group about the additional questions that could be asked about the participant's back pain and swimming ability and experience.

	Ranking (mean)	Preclass information	% agreement	Standard dev
1	1.53	Additional general health info	100%	0.52
2	1.6	Swim ability&experience	100%	0.51
3	1.67	About your back pain	93.33%	0.62
4	1.8	PARQ	93.33%	0.77
5	1.8	Aquatic screening form	80.00%	0.94

In the comments section there was some concern raised about the amount of questions, who would complete the form with the person; it was felt that it would be best for a medical person to complete form.

Based on the answers and comments in this survey a person attending the class would undergo a standard physiotherapy assessment, the aquatic therapy screening form would be used, additional questions would be asked about their back pain, swimming ability and experience. The reasons for collecting this information would be shared with the participant. If the participant consented, then this information would be available for the professionals leading the class and would be kept in strictest confidence. Do you have any comments about collecting this type of pre-class information? *(optional)*

Teaching approach

There are different methods of teaching and coaching swimming and different approaches to rehabilitation.

There was **at least 70% level of agreement** in the group that the following methods or approaches would be suitable for someone with back pain in a swimming class.

- An approach that takes into account the different types of back pain, that may respond differently to different swimming strokes and programs.
- An approach that focuses on swimming being used to increase levels of physical activity, making swimming fun with less focus on swimming as a form of exercise and less concern about technique.
- A kinaesthetic approach whereby participants consider how their body feels when they are swimming and make changes to their stroke based upon how they feel.

There was **less than 70% level of agreement** for the following option:

- A technical approach aiming at improving swimming technique

There was **less than 70% level of agreement** and a **wider range of responses** (target standard deviation <1.0 not met) for the following options:

- A visual approach including demonstrations and video feedback
- An approach that focuses on swimming as a form of exercise and training, encouraging swimmers to monitor progress and set goals
- A constructivist approach whereby the swimmer actively constructs what they learn, they problem solve, and the teacher facilitates the learning experience
- An instructional approach whereby a set lesson plan is delivered to a group of swimmers

	Ranking (mean)	Teaching approach	% agreement	Standard dev
1	1.8	Subgrouping back pain	93.33%	0.77
2	1.86	Increasing physical activity and fun	78.57%	0.95
3	1.93	Kinaesthetic	93.33%	0.7
4	2.53	Visual	53.33%	1.12
5	2.6	Form of exercise & training	53.33%	1.06
6	2.6	Constructivist	53%	1.06
7	3	Instructional	60.00%	1.41
8	3.13	Technical	33.33%	0.92

The comments supported that it would be more important to focus on physical activity than exercise. In the long term the approach might change, and it should be adaptable to the swimmer. One person felt that participants would not be comfortable being videoed and another felt that technique was important as using the wrong technique could cause more pain.

Based on the answers and comments in this survey the class would take into account the different types of back pain, the focus would be on increasing levels of physical activity, making swimming fun with less focus on swimming as a form of exercise. The participants would learn using a kinaesthetic approach, whereby participants consider how their body feels when they are swimming and make changes to their stroke based upon how they feel. Do you have any comments about using these type of teaching approaches? *(optional)*

Who could lead the swimming class?

Different people could take the swimming class.

There was **at least 70% level of agreement** in the group that the following professionals could take the swimming class.

- A collaboration by which both a physiotherapist and swimming teacher or coach lead the class.
- A Physiotherapist trained in aquatic therapy.
- A level 2 swimming teacher or coach with experience teaching adults.

Although there was at least 70% level of agreement, there were a **wider range of responses** for the following option (target standard deviation <1.0 not met)

- A collaboration by which a person with low back pain who has already completed the class joins the swimming teacher / coach or physiotherapist leading the class.

	Rank (mean)	Who should lead the class	% agreement	Standard dev
1	1.47	Physio & swimming teacher	93.33%	0.83
2	1.87	Physio	80.00%	0.74
3	2.2	Expert patient and physio / teacher	66.67%	1.15
4	2.33	Swimming teacher	66.67%	0.9

Comments included concerns that physiotherapists do not have training in how to teach swimming and a collaboration would be best so that the people in the class get the best possible teaching but are also supported with regards to their back pain from a physiotherapist.

Based on the answers and comments in this survey the swimming class would be led by both a physiotherapist and swimming teacher or coach. Do you have any comments about trialling this option? *(optional)*

Session Brief

There was **at least 70% level of agreement** in the group that the following items could be included in the session brief.

- Discuss any **concerns, fears, and barriers**; in relation to back pain, swimming or being in the water.
- Discuss **what to expect** and what is normal during and after a swim. They might experience some discomfort, mild shortness of breath and muscle fatigue; they should alert the teacher if they experience a significant increase in back pain or they feel unwell. Discuss pacing and when they should rest /pause between activities or lengths. Discuss their expectations; what do they want to achieve from the session.
- Explain why using **swimming as a rehabilitation tool**, the benefits, and problems with this type of approach and any guidelines. Include some discussion about not knowing which swimming stroke is best for back pain. Hopefully by the end of the class the swimmers will have developed a better understanding of what stroke(s) are best for their back. Also talk about the wider benefits of swimming such as impact on weight and mental health and how this could help in the management of their back pain.

	Rank (mean)	Session brief	% agreement	Standard dev
1	1.4	Concerns, fears and barriers	100%	0.51
1	1.4	What to expect	100%	0.51
2	1.67	Swimming as a rehab tool	86.67%	0.72

There were no additional comments for this section.

It is assumed that the following would be included prior to any swimming class; safety information, housekeeping, water temperature, depth, safety procedures, register changes in health, back pain, and wellbeing, are they well hydrated and when did they last eat. How to enter and exit water and summon help. Introduction to the type of session, session plan, which strokes, aims, objectives and the time the session will run.

Based on the answers in this survey the swimming class would include the above components in the session brief. Do you have any comments about trialling this type of session brief? *(optional)*

Warmup

There was **at least 70% level of agreement** within the group that the following **warm up activities** aimed at improving the experience of swimming with back pain could be included in a swimming class

- **Awareness activities: Awareness** activities including getting used to the sensation of the water and the feeling of weightlessness, how does this impact on movement and breathing. Feeling the sensation of their spine lengthening when moving through water. Bringing an awareness to their breathing using techniques and exercises. Acclimatisation to the water temperature, if the session is in different settings feeling what water temperature is best for their back.
- **Walking in water:** Walking in the water different directions, different speeds, with or without floatation aids, walking while doing sculling movements with arms.
- **Relaxation, floating and sculling**
- **Stretches:** Stretches in the water for back, neck, arms, and legs, including usual physio stretches. Finding out whether it is better for back to do stretches when they first get in pool or after some low intensity swimming.
- **Easy swimming:** Start with easy / low intensity swimming (front crawl and backstroke), gradually increasing intensity. Finding out whether it is better for them to warm up alternating strokes or with just one stroke.

There was **less than 70% level of agreement** and a **wider range of responses** (target standard deviation <1.0 not met) for the following option:

- **Light jogging** in the water

	Rank (mean)	Warm up	% agreement	Standard dev
1	1.67	Awareness activities	93.33%	0.62
2	1.69	Walking in water	94%	0.6
3	1.8	Relaxation, floating, sculling	93.33%	0.56
4	1.93	Stretches	80.00%	0.7
5	2.13	Easy swimming	81%	0.72
6	2.63	Light jogging	68.75%	1.02

Based on the answers in this survey, the warmup would include awareness activities, walking in water, relaxation, floating and sculling, stretches and easy swimming. *(Please note that not all aspects of this warmup would be included in each session, just one or two activities).* Do you have any comments about trialling this type of warm up? *(optional)*

Comments included the need for the warmup to be specific to the individual, not using language such as 'spine lengthening' and to support participants learning to feel how their body feels different in the water.
Based upon the comments the term spine lengthening will not be used but an awareness of lengthening of their trunk. Study 2 in this series of studies highlighted that this feeling of lengthening was important for swimmers with back pain.

- **Awareness activities: Awareness** activities including getting used to the sensation of the water and the feeling of weightlessness, how does this impact on movement and breathing. Feeling the sensation of lengthening through their trunk when moving through water. Bringing an awareness to their breathing using techniques and exercises. Acclimatisation to the water temperature, if the session is in different settings feeling what water temperature is best for their back.

Do you agree with the change?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Do you have any comments about the change of wording for this warmup section? *(optional)*

☐

Core aquatic skills

There was **at least 70% level of agreement** within the group that all the following **core aquatic skills** aimed at improving the experience of swimming with back pain could be included in a swimming class

- **Learning how to cope with a painful episode** when swimming, being able to indicate when they need support. Being able to get to the side or shallow water independently.
- **Water safety**, how to enter and exit the water, learning to make adjustments, trying different methods to reduce discomfort or accommodate for back pain, loss of strength and mobility. This could include using steps, sliding in, using ramps or hoists.
- **Learning to change position** in water (e.g., from front to back), using the core muscles during these transitions and relaxing the spine to allow it to move freely. Being aware how this feels different in the water when compared to being on dryland. Practicing different ways of turning at end of length, finding out which feels more comfortable. If nerve damage affecting one leg, then look at how could modify push off wall.
- Trying **hybrid strokes** if standard strokes do not agree with them, looking at different combinations of arm propulsion, kick, and body positions, which combination feels best for them. This could be considered if issues with other joints, such as shoulders or knees.
- **Learning to float**, trying different head, body, arm, and leg positions in water, feeling which ones are more comfortable for their back. Learning to relax while floating in the water. Learning how to stretch whilst floating. Using floating to increase core strength.

Using floating to deal with panic in the water or if experiencing cramp. Using equipment to support body whilst floating.

- Developing a **feel for the water** with hands through sculling, feeling how core muscles are recruited with this movement, trying sculling in different positions (on back, on front and vertical).
- **Learning how to tread water** and jog in deep water with a float, trying different arm and leg movements, feeling which movements are more comfortable for back.
- **Breathing exercises** with head out and in the water, mindful breathing, compare breathing out through mouth and nose, compare different speeds of inhalation and exhalation. Develop an awareness of how body feels with different styles of breathing, discover which variation feels more comfortable for back and breathing. Discuss concerns about putting face in water such as feeling claustrophobic. Learning how to fit and wear goggles so able to relax when breathing in water. Learn how breathing exercises can be used to manage anxiety, pain, and focus on the present moment.
- **Learning to glide** and move in a streamline way, trying different head, body, arm, and leg positions in the water, feeling which ones are more comfortable for back and which improve the efficiency of the movement through the water.
- **Awareness exercise**: do they feel more confident moving in the water than on land, can they do more in the water, do they have less fear of movement, does their back feel different in the water, do they have less back pain in the water, do their muscles feel more relaxed in the water, do they feel that the water is providing support for their back? Trying different movements that they struggle with on land in the water, if this movement feels easier, practising it in water. Learning to be in the present moment during swim.

	Rank (mean)	Core aquatic skills	% agreement	Standard dev
1	1.4	Coping with painful episode	100%	0.51
2	1.53	Water safety	100%	0.52
2	1.53	Learning to change position	100%	0.53
2	1.53	Hybrid stroke	100%	0.52
3	1.6	Learning to float	100%	0.51
3	1.6	Developing a feel for the water	93.33%	0.63
4	1.73	Learning to treadwater	93.33%	0.59
4	1.73	Breathing exercises	86.67%	0.88
5	1.79	Learning to glide	93.33%	0.8
6	1.8	Awareness exercise	87.50%	0.83

Based on the answers in this survey all of the core aquatic skills above would be included in the class. Do you have any comments about trialling these core aquatic skills? *(optional)*

There was one comment made about focusing on having less pain in the water and that it would be better to focus on what they are achieving instead.

Based upon this comment the awareness exercise will no longer include 'do they have less back pain in the water'.

- **Awareness exercise**: do they feel more confident moving in the water than on land, can they do more in the water, do they have less fear of movement, does their back feel different in the water, do their muscles feel more relaxed in the water, do they feel that the water is providing support for their back? Trying different movements that they struggle with on land in the water, if this movement feels easier, practising it in water. Learning to be in the present moment during swim.

Do you agree with this change?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Do you have any comments about the change in wording for this core aquatic skills section? *(optional)*

Swimming strokes: Front crawl teaching teachings and drills/ exercises

There was **at least 70% level of agreement** within the group that the following teaching points and drills/exercises aimed at improving the experience of swimming **front crawl** with back pain below could be included in a swimming class

- **Breathing:** Being mindful to exhale in the water and to inhale the normal amount of air, not hyperventilate. Practising different intervals when taking a breath. Compare breathing through mouth and nose. Practise different speeds of inhalation and exhalation. Compare different head positions when taking breath to the side. Discover which variation feels more comfortable for back and for breathing.
- **Problem solving:** Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back.
- **Nerve damage:** If unable to use legs whilst swimming (e.g., due to nerve damage) finding ways to swim and keep in a streamline position either with floats, using core or increasing speed. If nerve damage only affecting one leg, find out whether better for back to use just one leg or no legs.
- **Streamline:** Learning how to adopt a more streamline position in the water for their body so that less effort required to swim, adding a pull buoy or flotation trunks if required so swimming close to surface.
- **Rotation: I**mproving rotation of the trunk so that the whole body rotates, learning to breathe both sides if possible. Learning to move smoothly through water using this rotation. Drills to enhance rotation could include 6 kicks and roll and a single-arm drill. Do they feel better using front crawl to improve the rotation in spine or is it more comfortable to rotate the whole body?

Although there was at least a 70% level of agreement, there were a **wider range of responses** (target standard deviation <1.0 not met) for the following options:

- **Head down:** Learning to swim front crawl with head looking straight down, not forwards to relax neck and back muscles and not extend lumbar spine.

- **Lengthening:** Increasing the feeling of lengthening in the spine whilst swimming with stronger pull and not 'over kicking', The following drills could be used; arms only with pull buoy, catchup, focusing on extending the arm in front before the next stroke, trying different kick beats (6,4,2) and feeling difference with back.

There was **less than 70% level of agreement** for the following option:

- **Body position:** Learning to swim front crawl with lower body position in the water, at an angle rather than in line with the water surface; lifting the back and dropping the legs in the water so that lumbar spine is in less extension / neutral position. Optional use of equipment such as noodles under trunk to support swimmer in this position.

	Rank (Mean)	Front crawl	% agreement	Standard dev
1	1.6	Breathing	100%	0.63
2	1.67	Problem solving	93.33%	0.82
3	1.87	Nerve damage	93.33%	0.52
4	2.07	Streamline	86.67%	0.8
5	2.2	Rotation	86.67%	0.86
6	2.27	Head down	73.33%	1.1
7	2.44	Lengthening	75.00%	1.09
8	2.9	Body position	44%	0.89

Based on the answers in this survey the following teaching points and drills would be included in a class: breathing, problem solving, adapting for nerve damage, streamline and rotation (please see above for full description). Do you have any comments about trialling these front crawl teaching points and drills / exercises? *(optional)*

Comments included:

- Less emphasis on lengthening the spine and caution against unhelpful messages about posture and the spine. Better to help them find what works than focus on a particular posture.
- Caution also using problem solving with newer swimmers until their confidence has grown.
- Survey respondents had different views about head position; head down but eyes forward, different teaching and coaching methods have different views on head position. The head position affects the legs, if you raise the trunk the legs will sink, increasing resistance and arching the back as the swimmer attempts to correct leg drop.
- There was concern about too much buoyancy and resistance if the swimmer uses a noodle, it would be better to learn to deal with own buoyancy. A noodle would prevent rotation and could trigger back spasm.
- It was felt that some of the drills were not appropriate and were geared towards coaching and not the average recreational swimmer. For example, catch up drill was advised against. Extension through the arm should be achieved through body rotation.

Based upon the comments the section about head position will be changed to

- **Head position:** Practicing different head positions whilst swimming front crawl, taking care not to swim with the head too high in the water, feeling how different positions affect their neck, body position in the water and back.

The sections on lengthening and body position will no longer be included.

Do you agree with this change?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Do you have any comments about the change of wording of the section on head position? *(optional)*

Swimming strokes: Backstroke teaching teachings and drills/ exercises

There was **at least 70% level of agreement** within the group that the following teaching points and drills/exercises aimed at improving the experience of swimming **backstroke** with back pain below could be included in a swimming class.

- **Problem solving:** Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back.
- **Breathing:** Being mindful to exhale through nose so water does not enter nose whilst on back and to inhale the normal amount of air, not hyperventilate. Practising different intervals when taking breath with stroke. Practise different speeds of inhalation and exhalation. Discover which variation feels more comfortable for back and for breathing.
- **Other forms of backstroke:** Learning alternative ways to swim on back such as old English backstroke (breaststroke kick and double arm pull) or sculling with breaststroke or flutter kick, being aware how back feels with different versions of stroke.
- **Head position:** Learning to swim backstroke with head looking up, not down the pool to relax neck muscles and to reduce sinking of legs, being aware how head position changes low back position whilst swimming. Learning to follow ceiling or if outside shore or bank to reduce disorientation in this position and to keep swimming course straight.
- **Using the flags:** Learning how to use the flags when swimming backstroke so able to judge how close to the end and therefore allowing the swimmer to stay on their back and relax when swimming this stroke
- **Rotation:** Learning how to improve rotation of body during backstroke. Being aware how this could increase the feeling of lengthening in spine and improve the efficiency of the arm pull. Do they feel better using back stroke to improve the rotation in the spine or is it more comfortable to rotate the whole body? Using this rotation to

move smoothly through water. Drills: single arm pull, not over kicking, kick only to keep legs in correct position in water

There was **less than 70% level of agreement** for the following options

- **Body position:** Learning to swim backstroke with body on the surface of the water and a slight angle downwards with legs, but not allowing legs to sink too much so less extension in lower back. Feeling that movement through water in this position is more streamline and less effort is required. Drills include kicking with the noodle underarms, kicking on back hugging float, using small pull buoy, wearing floatation trunks.

	Rank (mean)	Backstroke	% agreement	Standard dev
1	1.87	Problem solving	93.33%	0.74
2	1.87	Breathing	86.67%	0.64
2	1.87	Other forms of backstroke	86.67%	0.64
3	2	Head position	80.00%	0.65
4	2	Using the flags	86.67%	0.76
5	2.19	Rotation	75.00%	0.54
6	2.5	Body position	56%	0.82

Based on the answers and comments in this survey all teaching points and drills above, apart from the one which discussed body position would be included in the class. Do you have any comments about trialling these backstroke teaching points and drills/ exercises?

Comments included that the body position would depend on the individual, the core muscles were important for body position. There was some concern that the drills were inappropriate by one participant, but another felt that the drills using floatation equipment would be useful. There was concern about the term lengthening the spine and promoting unhelpful beliefs about posture and the back.

Based upon the comments the term lengthening the spine will be changed to lengthening through the trunk.

- **Rotation:** Learning how to improve rotation of body during backstroke. Being aware how this could increase the feeling of lengthening through the trunk and improve the efficiency of the arm pull. Do they feel better using back stroke to improve the rotation in the spine or is it more comfortable to rotate the whole body? Using this rotation to move smoothly through water. Drills: single arm pull, not over kicking, kick only to keep legs in correct position in water

Do you agree with the changes?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree

☐ Strongly disagree
☐ Unsure

Do you have any comments about the change in wording of backstroke teaching points and drills / exercises? *(optional)*

☐

Swimming strokes: Breaststroke teaching teachings and drills/ exercises

There was **at least 70% level of agreement** within the group that the following teaching points and drills/exercises aimed at improving the experience of swimming **breaststroke** with back pain below could be included in a swimming class.

- **Breathing:** Being mindful to exhale in the water and to inhale the normal amount of air, not hyperventilate. Practising different lengths of glide, which will affect intervals when taking a breath and different speeds with stroke transitions (e.g., from pull to glide). Compare breathing through mouth and nose. Practise different speeds of inhalation and exhalation. Discover which variation feels more comfortable for back and for breathing.
- **Problem solving** trialling different head, body and leg positions for each swimmer, learning how to make the stroke more comfortable for their back.
- **Head position:** Practising different head positions during the stroke cycle, allowing the head to dip to relax neck muscles when face in the water, feeling how different positions effect their neck and back.
- **Kick pull ratio:** Trying different ratios of kick and pull, e.g., two kicks to one pull so longer period when flatter in water, feel the difference with different ratios on back.
- **Kick on back:** Learning how to do breaststroke kick on back, with sculling arms or double arm pull (old English backstroke), feeling how this change in position affects their back, is there less lumbar extension? Use this position on back to improve awareness and develop breaststroke kick. Use noodle if requires support initially. Alternately stroke on front and back, if back better changing position more frequently.
- **Undulation:** Trying breaststroke with more and less undulation. Do they feel better using more undulation to mobilise the lumbar spine or less undulation?
- **Underwater:** Experiencing swimming breaststroke under the water, for example trying the drill; 3 kicks above water, 3 kicks below the water or breaststroke legs only under water. Being aware of feeling of weightlessness under underwater and lengthening of spine.
- **Flatter stroke:** Learning a flatter breaststroke with slower stroke turnover (less ballistic), longer glide and wedge kick (the older style of swimming breaststroke). Being aware of the feeling of lengthening through spine during glide phase.
-

	Rank (Mean)	Breaststroke	% agreement	Standard dev
1	1.6	Breathing	100%	0.51
2	1.69	Problem solving	94%	0.6
3	1.81	Head position	94%	0.54
4	1.93	Kick pull ratio	86.67%	0.8
5	2	Kick on back	81%	0.97
5	2.06	Undulation	81.25%	0.57
6	2.07	Underwater	78.57%	0.62
7	2.19	Flatter stroke	81%	0.83

Based on the answers and comments in this survey all teaching points and drills will be included in the class. These include breathing, problem solving, head position, kick pull ratio, kick on back, undulation, underwater and flatter stroke. Do you have any comments about trialling these breaststroke teaching points and drills/ exercises? *(optional)*

Comments for this section included not talking about lengthening the spine, less focus on how stroke affects back so not promoting hypervigilance and not assuming that less lumbar extension is better.
Based upon these comments the sections which mentions lengthening the spine will be changed to lengthening through the trunk and no mention will be made of lumbar extension. Care will be taken to balance the need for some awareness but not promoting hypervigilance.

- **Kick on back:** Learning how to do breaststroke kick on back, with sculling arms or double arm pull (old English backstroke), feeling how this change in position affects their back. Use this position on back to improve awareness and develop breaststroke kick. Use noodle if requires support initially. Alternately stroke on front and back, if back better changing position more frequently.
- **Underwater:** Experiencing swimming breaststroke under the water, for example trying the drill; 3 kicks above water, 3 kicks below the water or breaststroke legs only under water. Being aware of feeling of weightlessness under underwater and lengthening through the trunk.
- **Flatter stroke:** Learning a flatter breaststroke with slower stroke turnover (less ballistic), longer glide and wedge kick (the older style of swimming breaststroke). Being aware of the feeling of lengthening through trunk during glide phase.

Do you agree with these changes in wording?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Do you have any comments about the change in wording of breaststroke teaching points and drills/ exercises? *(optional)*

Cool down

There was **at least 70% level of agreement** in the group that the following **cool down activities** aimed at improving the experience of swimming with back pain could be included in a swimming class.

- **Stretches:** Gentle stretches in the water, specific stretches advised by physiotherapist. Do they have more movement now, does the movement feel easier compared to the start of the session?
- **Walking in water:** Walking in water and gentle movements with a fun element
- **Sculling and relaxation:** Sculling on back with or without breaststroke kick and just kicking. Breathing, relaxation, floating on back, meditation type breathing exercises.
- **Easy swimming:** Easy / low intensity swimming, changing the stroke from the main set, e.g., if swam on front then would cool down on back.

There was **less than 70% level of agreement** and a **wider range of responses** (target standard deviation <1.0 not met) for the following option

- **Old English Backstroke:** Old English backstroke; double arm with breaststroke kick

	Rank (mean)	Cool down	% agreement	Standard dev
1	1.75	Stretches	88%	0.68
2	1.75	Walking in water	94%	0.58
3	1.8	Sculling	93.33%	0.56
4	1.87	Easy swimming	86.67%	0.83
5	2.33	Old english backstroke	53.33%	1.18

Based on the answers in this survey the cool down would include stretches, walking in water, sculling and relaxation, floating and easy swimming. *(Please note that not all aspects of this cool down would be included in each session, just one or two activities)* Do you have any comments about trialling this cool down? *(optional)*

Comments included that the cool down should be fun and relaxing and should mainly include stretching. Caution was advised against checking if they had more movement when stretching in the cool down, if they don't gain movement, it might not mean that it is not helpful. Be careful with the emphasis and expectations.
Based upon these comments I agree the cool down section should be fun and relaxing and during the stretches, the section on seeing if they gained will be removed.

- **Stretches:** Gentle stretches in the water, specific stretches advised by physiotherapist. Does the movement feel easier compared to the start of the session?

Do you agree with these changes?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Do you have any comments about the change of wording for this cool down section? *(optional)*

Session debrief

There was **at least 70% level of agreement** within the group that the following could be include in the **session debrief**

- Explain how the person might **feel afterwards** and how to deal with it. Flare up of pain, advice / reassurance, and safety netting.
- Cover any **teaching / coaching points** that were difficult to communicate while they were in the water or as a group. What could they adjust or adapt in the next session.
- **Positive feedback** from teacher / coach. Finish with a reflection on achievements, not problems.
- **What to work on** before the next session? Goals for the following week? Motivational tools they could consider? What will be covered in the next session. Dryland exercises they could try this week. Do they need any equipment next week?
- **Reflection** on class, general feedback from swimmer. What they expected versus what they achieved during session? How it felt, was any of the session uncomfortable for their back, do they have any concerns? What went well, what did they enjoy, what was more challenging, what did they dislike? What stroke(s) were best for their back in this session? How are they feeling physically and psychologically? Relate to key values or goals.

	Rank (mean)	Session debrief	% agreement	Standard dev
1	1.4	What to expect after class	100%	0.51
1	1.4	Teaching points	100%	0.51
1	1.4	Positive feedback	93.33%	0.63
2	1.47	What to work on before next session	100%	0.52
3	1.62	Reflection on class	94%	0.62

Based on the answers in this survey all the components of the session brief above would be included in a class. Do you have any comments about trialling this session debrief? *(optional)*

Comments included that some participants might want to discuss problems privately and self-reflection should be personal, and they should not be encouraged to share reflections with

others. It was suggested that the focus should be on what went well, and caution was advised about participants not knowing what was best for their back.

Based upon these comments the reflections would not be share with the class, but the participants will still be encouraged to reflect. The section asking the participant to reflect on 'what stroke is best for their back 'will be changed to 'what did they find most beneficial'.

- **Reflection** on class (not shared), general feedback from swimmer. What they expected versus what they achieved during session? How it felt, was any of the session uncomfortable for their back, do they have any concerns? What went well, what did they enjoy, what was more challenging, what did they dislike? What did they find most beneficial? How are they feeling physically and psychologically? Relate to key values or goals.

Do you agree with the change?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Do you have any comments about the change of wording for this session debrief section? *(optional)*

Keeping going with swimming

There was at least 70% level of agreement within the group that the following could be included to help participants keep swimming after the class.

- Making the swimming sessions fun, enjoyable and sociable.
- Subsidised / discounted access to pool.
- Information about access to local pools and cost. Information about changing facilities. Discuss about taking time to prepare to get in the water and to leave the venue. Information about outdoor swimming sessions with further information about safety.
- Developing a peer support group with others in the class, using social media such as WhatsApp or Facebook.
- Time to reflect on other benefits of swimming, beyond their back pain, such as improvements in fitness, general health, wellbeing, mood, general muscle strength and flexibility, and being better able to manage a healthy weight. Use these benefits as an additional motivational tool.
- Encouragement and positive feedback from person leading the class, highlighting improvements since swimming. Time to reflect on benefits for back pain and general health.
- Signposting to sessions for only adults and for just women or just men.

- Offering a session whereby a partner, family member or friend can join them in the water.
- Setting goals, being comfortable prioritizing self so able to swim regularly and making a written action plan before the last session.
- Further drop-in sessions at pool.

There was **less than 70% level of agreement** for the following options

- Integration with regular classes in local pool.
- Email or text prompts to remind them to book a swim session.
- Paperwork to support what they have learned during the class
- Signing up for a challenge or an event to work towards for example the Swimathon challenge. If not entered an event before, discussing what to expect, so able to enter 'that world', if not from a sporty background. Monitoring swims with an App such as Strava.

	Rank (mean)	Keeping going	% agreement	Standard dev
1	1.44	Making swimming fun, enjoyable, sociable	100%	0.51
2	1.47	Discounted swimming	100%	0.52
3	1.53	Information access to local pool	100%	0.52
4	1.6	Developing a peer support group	100%	0.51
5	1.6	Time to reflect on benefits	93.33%	0.63
6	1.6	Encouragement and positive feedback	93.33%	0.63
7	1.8	Signpost sessions for adult only / men only / women only	86.67%	0.86
8	1.8	Session with family / friend	80.00%	0.77
9	1.87	Setting goals	80.00%	0.92
10	1.87	Further drop in sessions	73.33%	0.99
11	2.13	Integration with local classes	66.67%	0.92
12	2.31	Emails/ text reminders	63%	0.79
13	2.47	Paperwork to support learning	47%	0.99
14	2.56	Signing up for challenges	50%	0.96

Based on the answers in this survey the points above which achieved more than 70% agreement will be included in the class. These include making swimming fun, enjoyable and sociable, offering discounted swimming, providing information about access to local pools, developing peer support groups, taking time to reflect on the benefits, providing encouragement and positive feedback, signposting to sessions, offering a session when a member of their family or a friend can join, setting goals and providing further drop-in sessions. Do you have any comments about trialling these strategies to help keep people swimming after they have finished the class? *(optional)*

Comments included the reason why paperwork was not recommended but an online app such as Swim phony or Course Pro might be better.

Based upon these comments the strategies to help the participant keep swimming after the class would be better supported through an app and not paperwork.

Do you agree with the change?

- ☐ Strongly agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly disagree
- ☐ Unsure

Further comments

Do you have any other thoughts you would like to share about developing a swimming class for people with low back pain?

Thank you very much for participating in this survey. Please let me know when you have completed it so that I can send you a thank you voucher.

If you have any queries, please contact me on

Appendix G: Joint Display Tables Study Three

Set up of programme				
Study three Round one QUAL	**Study one and Scoping review QUAN**	**Study two QUAL**	**Meta inferences, interpretations, and COM-B and BCW analysis**	**Study three Round two QUAN**
Length of session				
Code: Time in water (AP) (Time in minutes, range of times) *'Around 20-30 minutes.' (P7 SP)* *'45 mins.' (P5 Ph)* *'No more than 30 minutes.' (P11 SP)* *'Approx. 30 mins to 1 hour.' (P12 LBP)* *'30 minutes to 60 minutes.' (P13 LBP)*	No data study one Scoping review: 90 minutes Aquatic and land-based exercises and swimming (Ariyoshi et al. 1999) 40 minutes swimming (Kim, Kim, and Jung 2008) 30 minutes just swimming (Weifen et al. 2013) 40 minutes aquatic exercise and swimming (Winter and McCauley-Callagy 2002)	**Theme: How swimming looks for me; COM-B Physical and psychological capability, physical and social opportunity** *'I go in everyday, probably for about 15 minutes.' (S10 Outdoor swimmer)* *'25 minutes to an hour.' (S7 Outdoor swimmer)* *'We probably stay in at the most for about 20 minutes.' (S9 Outdoor swimmer)* *'One hour.' (S11 Pool swimmer)* *'40 minutes to 1 hour.' (S3 pool swimmer)* *'45 minutes to an hour is usually what I would normally do on my own.'*	**Convergence** Two a priori codes were used to analyse the data from the round one survey to guide the length of the session: *time in water and considerations*. When the data was integrated from study two the data was congruent based upon the theme, *how swimming looks for me*. The theme suggested that there were many personal and external factors which could impact the length of the session. Based upon the range of suggested times from the round one survey, the proposed average time for the session in round two was 30 minutes. When mapped onto the COM-B model the frequency of sessions would related to	**The following set up of programme was suggested in the round two survey** The length of the swimming session would depend on the individual, but the average time offered would be 30 minutes. **COM-B Physical and psychological capability, physical and social opportunity** **BCW Intervention function Enablement**

		(S12 Pool swimmer)	the physical and social opportunity and physical and psychological capability dimensions and the intervention function would be enablement.	
Code: Considerations (AP) (Considerations regarding time in water) **COM-B: Physical capability** *'Think it should be built up over the course of treatment.' (P4 Ph)* *'30-45 minutes depending on the temperature of the water and the ability of the patient, whether adult or child. Adults tend to take longer to get warmed up both mentally and physically.' (P1 SP)* *'Totally depends on the person. All swimming activity should be coached to the swimmers needs not a generic.' (P2 SP)* *'Variable it should begin with a small amount of time but can increase as patient responds.' (P6 Ph)* *'Depends on skill set of swimming and overall condition but would suggest 30-45 minutes.' (P3 SP)*		**Theme: How swimming looks for me; COM-B Physical and psychological capability, physical and social opportunity** *'You don't have a choice! Yes, it is an hour session. Yes, the one in the Lido you are allowed in 5 minutes before the session. Yes, it is usually an hour, 40 minutes. In the class we are doing an hour session as well.' (S5 Pool and outdoor swimmer)*		

Frequency of sessions				
Code: Frequency of sessions (AP) (Frequency of sessions each week) *'Once or twice a week' (P1 SP)* *'2-3 times a week.' (P3 SP)* *'x2 per week.' (P5 Ph)* *'Twice a week.' (P6 Ph)* *'Once a week initially increasing to twice or three times a week.' (P9 LBP)* *'2-3 times a week.' (P11 SP)* *'Once a week initially.' (P16 SP)*	No data study one Scoping review: 1-3 times a week (Ariyoshi et al. 1999) 3 times a week (Kim, Kim, and Jung 2008) 5 times a week (Weifen et al. 2013) Twice a week (Winter and McCauley-Callagy 2002)	**Theme: How swimming looks for me; COM-B Physical and psychological capability, physical and social opportunity** *'At the moment I go 4 or 5 mornings, and it is about 40 minutes and Wednesday evening for an hour.' (S3 Pool swimmer)* *'I try and swim at least once or twice a week. And up to an hour really.' (S13 Outdoor swimmer)* *'3 sessions a week.' (S4 Pool and outdoor swimmer)* *'5 to 6 times.' (S5 Pool and outdoor swimmer)* *'Twice a week.' (S11 Pool swimmer)* *'On average it is 4 days a week that I am doing.' (S14 Pool swimmer)*	**Convergence** Two a priori codes were used to analyse the data from the round one survey to guide the frequency of the session: *frequency of sessions and considerations*. When the data was integrated from study one and two the data was congruent based upon the barriers data and the theme, *how swimming looks for me*. The barriers data had found that 47.5% of people would find it difficult to find the time to go swimming and the theme, *how swimming looks for me,* suggested that there were many personal and external factors impacting swimming frequency. Based upon the range of suggestions from the round one survey, the proposed frequency for the sessions would be once to twice a week. When mapped onto the COM-B model the frequency of sessions would related to the physical and social opportunity and	**The following set up of programme was suggested in the round two survey** The frequency of the swimming session would depend on the individual, but the average frequency offered would be once to twice a week. **COM-B Physical and psychological capability, physical and social opportunity** **BCW Intervention function Enablement**
Code: Considerations (AP)	**Barriers**	**Theme: How swimming looks for me; COM-B**		

(Considerations regarding frequency of sessions) *'Benefits from swimming increase the more frequently it is done.' (P13 LBP)* *'Little and often is a golden rule but helpful I think to run a course with a couple of times per week to begin.' (P8 Ph)* *'Depending on severity and cause, between one and two per week.' (P7 SP)* *'If cost is no object, twice a week. (P4 Ph)*	47.5% agreed that they would hard to find the time to go swimming during the week; **COM-B Physical opportunity**	**Physical and psychological capability, physical and social opportunity** *'Twice a week, That fits in with work and everything else.' (S8 Pool swimmer)* *'I have a job and that doesn't always let me, so I try if I can. I would say about 5 days out of 7.' (S9 Outdoor swimmer)* *'The aim is for an hour, that's the marker and at least once a week. If I was lucky, I would probably go twice. It all depends on my shift cycle.' (S2 Pool swimmer)* *'The availability of pool time.' (S2 Pool swimmer)*	physical and psychological capability dimensions and the intervention function would be enablement.	
Number in session				
Code: Number in session (AP) (How many people in session) *'4-6 people' (P1 SP)* *6-8 (P3 SP)* *5 (P5 Ph)*			**No data for meta inference** Two a priori codes were used to analyse the data from the round one survey to guide the number in the session: *number in session and considerations*. There was no data from study one and two for meta inference. When mapped onto the COM-B	**The following set up of programme was suggested in the round two survey** The number in the sessions would be dependent on several factors but the average number in the session would be five people.

4-5 (P6 Ph)			model the number in the sessions would related to the physical and social opportunity and physical and psychological capability dimensions and the intervention function would be enablement.	**COM-B Physical and psychological capability, physical and social opportunity** **BCW Intervention function Enablement**
Code: Considerations (AP) (Considerations regarding number of people in sessions) *'Approx. 5 people to allow for an intimate setting but maybe be able to offer 1:1' (P12 LBP)* *One would be ideal, but a qualified swim teacher is trained to teach different abilities at one time. Working with one swimmer at a time allows a better understanding between coach and swimmer it also allows for teacher in the water to demonstrate/assist if required. (P2 SP)* *For health and safety no more than two participants initially. If the back pain is causing the back to seize up, then just one participant. Once participants are confident and are able to move continuously then class sizes could increase to no more than 4. (P7 SP)*				

Depends on the number of teachers/lifeguards I think but ideally 6 to 10 people to benefit from peer learning and support (P8 Ph) *Approx. 5 people to allow for an intimate setting but maybe be able to offer 1:1. (P12 LBP)*				
Time of session				
Code: Time of day (AP) (What time of day to offer the session) *'Mid-morning/mid-afternoon' (P6 Ph)* *During day. (5 Ph)* *Mid-morning/mid-afternoon. (6) (Ph)* *Morning. (16 SP)*	**Preferences** 34% of participants would prefer to swim between 9-12pm and 21.1% would prefer 5-7pm	**Theme: How swimming looks for me; COM-B Physical and psychological capability, physical and social opportunity** *'4 or 5 mornings and Wednesday evening' (S3 Pool swimmer)* *'I like swimming in the afternoon, I hate doing any exercise in the morning.' (S6 Pool and outdoor swimmer)*	**Convergence and Complimentary** Two a priori codes were used to analyse the data from the round one survey to guide the time of the session: *time of day and considerations*. When the data was integrated from study one and two new insights were observed based upon the preference data from study one and the data was congruent with the theme, *how swimming looks for me*. The preference data had identified that 34% of participants would prefer to swim between 9-12pm and 21.1% between 5-7pm. The theme, *how swimming looks for me,* suggested that there	**The following set up of programme was suggested in the round two survey** The swimming sessions will be offered at different times during the day, except for early morning and late evening **COM-B Physical and psychological capability, physical and social opportunity** **BCW Intervention function Enablement**
Code: Considerations (AP) (Considerations regarding the time of day to offer session) *'Afternoon. It takes me most of the morning to be able to get moving enough to get out of the house' (P13 LBP)*		**Theme: How swimming looks for me; COM-B Physical and psychological capability, physical and social opportunity** *'If I am swimming in the morning, I do need to stretch*		

Pre work or post work slots to cover a broad spectrum and to get appropriately qualified teachers/coaches. (P3 SP) *Early afternoon or late morning. I am normally in more pain in the mornings and evenings.... evenings may be beneficial if it's a more relaxing class and not as physically straining. (P12 LBP)* *Depends on the individual it should be at a time when the patient can attend around work commitments. (P1 SP)*		*before I go in. It used to be that I couldn't really swim properly, I couldn't do tumbles in the morning because I couldn't get round.' (S3 Pool swimmer)*	were many personal and external factors impacting the time of the session. Based upon the integration of the data the proposed programme would be offered at different times during the day, except for early morning and late evening. When mapped onto the COM-B model the frequency of sessions would related to the physical and social opportunity and physical and psychological capability dimensions and the intervention function would be enablement.	

Pre-programme information				
Study three Round one QUAL	**Study one QUAN**	**Study two QUAL**	**Meta inferences, interpretations, and COM-B and BCW analysis**	**Study three Round two QUAN**
General health				
Code: Current medical history (AP) (What medical conditions so they have aside to LBP) *'Whether they have any underlying health conditions' (P1 SP)* *'General medical health screen, similar to hydrotherapy.' (P5 Ph)* *'That they have no underlying health problems such as heart problems, high blood pressure, diabetes, mobility issues, whether they have hearing or sight loss etc so that we know the best way to help support them to swim/move in the water.' (P7 Sp)*		**Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability** *'I have got issues with knees as well, so breaststroke isn't my first choice so I certainly can't do more than probably about 4 lengths of breaststroke because again, it is the position, it does slightly extend my back, so it is pretty much front crawl and back crawl that I do.' (S14 Pool swimmer)* *'I suffer with depression.' (S9 Outdoor swimmer)*	**Convergence and Complimentary** Four a priori codes and one in vivo code were used to analyse the data from the round one survey to guide the questions about general health: *current medical history, drug history, contraindications, screening, and function*. When the data was integrated from study one and two, new insights were observed based upon the adverse reaction data from study one and the data was congruent with the barriers data from study one and the subthemes, *my barriers to swimming and how I overcome them and how I manage my back pain.* The subtheme, *my barriers and how I overcome them*, discussed how people with LBP have to consider other conditions when swimming, not just LBP, supporting the	**The following pre-programme information was suggested in the round two survey** **General health questions** Heart condition or chest pain when exercise Blood clots, stroke, blood thinners, blood clotting disorder Hypertension or aneurysm Respiratory condition or short of breath on exertion, Issues with skin such as wounds, fragile skin, sensitive to chlorine Diabetes Dizzy spells, poor balance, fits, seizures of fainting Operation, radiotherapy, or chemotherapy in last 3-months Bladder or bowel disturbances Are they already doing regular exercise or activities
Code: Drug history (IV) (Do they have to take medication) *'Do they have any medication they need with them and accessible' (P11 SP)*		**Subtheme: How I manage my back pain; COM-B Psychological capability** *'The only tablet I will take is an ibuprofen; I do not want to*		

'Past medical history, weight, allergy status, current medication list.' (P6 Ph)		*take anything else.' (S8 Pool swimmer)* *'If it gets really bad, I will take over the counter medicines.' (S14 Pool swimmer)* *'So, I take Nortriptyline at night. I have got co-codamol.' (S6 Pool and outdoor swimmer)*	need to collect current medical history. The subtheme, *how I manage my back pain*, discussed how people with LBP may be on several forms of medication, supporting the need for the collection of drug history. The adverse reaction data from study one had identified that ear and nose and sinus problems were the most common adverse reaction and the subtheme, *my barriers to swimming and how I overcome them*, had highlighted the side effects of chlorine for some swimmers and the need to ask about reactions to chlorine. The barriers data had identified functional barriers relating to worries about falls and slips, difficulty getting changed, walking from the car park to the pool and from the changing room to the swimming pool, supporting the need to ask about levels of function and physical activity.	where they are physically active Current weight and height Do they suffer from fatigue Visual or hearing impairment Medication on poolside Do they use a walking aid, do they need this on poolside? Worried about falling or slipping, what can we do to help? If the swimming teacher or coach is unsure that the person is safe to start swimming, they could consult their GP or Physiotherapist **COM-B: Physical and psychological capability** **BCW Intervention function Enablement**
Code: Contraindications (AP) (What contraindications or precautions do they have to taking part in the programme) *'No open wounds/cellulitis, Any active infection, Bowel incontinence' (P4 Ph)* *'Any contraindications to swimming' (P8 Ph)*	The most common adverse reaction mentioned was ear problems (n=4), followed by nose and sinus problems (n=3), two participants mentioned eye issues or concerns about eyes and two participants mentioned two conditions affecting the foot associated with swimming: verruca and toenail fungus. One participant mentioned that freestyle and backstroke tends to cause shoulder pain and another participant mentioned suffering a back spasm whilst swimming.	**Subtheme: My barriers to swimming and how I overcome them; COM-B Physical and psychological capability** *'I am not a massive fan of swimming pools and I always just get a really sore throat after swimming in a swimming pool, you know that kind of heavy chlorine. I always felt intimidated but super-fast swimmers, you know the lanes, and the tumble turns. I was in the slower lane, so I think that is another reason why I turned to the open water because it seemed like a lot less stress going there.' (S10 Outdoor swimmer)*		
Code: Screening tools (AP)				

(Are there any standard screening tools that could be used) *'General medical health screen, similar to hydrotherapy' (P5 Ph)*			When mapped onto the COM-B model the general health questions would related to the physical and psychological capability dimensions and the intervention function would be enablement.	
Code: Function (AP) (Questions about function, levels of physical activity and mobility) *'Do they need assistance to enter and exit the pool?' (P9 LBP)* *'How mobile are they, can they manage to get in and out of the pool unaided? Do they need assistance to enter and exit the pool?' (P9 LBP)*	**Barriers** 43.9% agreed that they were worried about falling or slipping in the pool area or changing rooms; **COM-B Psychological capability** 32.1% agreed that they would struggle getting changed due to their back pain; **COM-B Physical capability** 19.5% agreed that they would find it hard to go swimming if they could not park close to the pool; **COM-B Physical capability** 12.2% agreed that they would find it difficult to get from the changing room to the pool; **COM-B Physical capability**			
Back pain				
Code: Diagnosis (AP) (Specific diagnosis and / or cause of LBP)		**Subtheme: Understanding my back pain; COM-B Psychological capability**	**Convergence** Seven a priori codes and two in vivo codes were used to	**The following pre-programme information**

'Where it is and what is it in order to relate stroke activity to the individual' (P3 SP) *Location, how it impacts on movement. Need to know any specific risks associated, e.g. possible fall risk or paralysis. (P13 LBP)* *The cause of the back pain, severity on any given day, site of the pain. Any movement that may exacerbate the problem. How mobile they are. (P7 SP)*		*'And they just said that I have got arthritis in my SI joints.' (S13 Outdoor swimmer)* *'I have got a couple of ruptured discs.' (S2 Pool swimmer)* *'It was a pars fracture.' (S14 Pool swimmer)*	analyse the data from the round one survey to guide the questions about back pain: *Diagnosis, pain, aggravating and easing factors, how long, mobility, advice, strategies, avoid or push too hard and expectations.* When the data was integrated from study one and two the data was congruent based upon the barriers and enablers data from study one and the subthemes, *understanding my back pain, how my back pain started, more than just back pain, how I manage my back pain and my swimming journey*. The subtheme, understanding my back pain, discussed the range of different back pain diagnosis, supporting the collection of this data. The subtheme, *understanding my back pain*, discussed the different pains people with LBP might experience and aggravating, and easing factors with LBP, the subtheme, *how my back pain started*, discussed the	**was suggested in the round two survey** **Questions about back pain** Diagnosis / cause of back pain? Further information about your back pain; how long have you had it, location of pain, type of pain and intensity. What makes your back pain better and what makes it worse? How easy is it to provoke or increase your back pain (irritability), do you get frequent flare ups? How mobile is your back? Which movements are restricted (back, legs and arms)? Do they have a foot drop of weakness?
Code: Pain (AP) (The location of the LBP and other pains, type of pain and intensity) *'Type of pain and location of pain' P12 LBP)* *Duration of pain, intensity of pain, current coping strategies, views of support networks, financial setting, i.e. is person receiving benefits which may be mediated by the disability caused by back pain. (P15 Ph)*		**Subtheme: Understanding my back pain; COM-B Psychological capability** *'So, the back pain, how do you describe it, it goes into spasm, it feels very heavy.' (S8 Pool swimmer)* *'I have back pain there all the time.' (S2 Pool swimmer)*		

Code: Aggravating and easing factors (AP) (What aggravates and eases their LBP) *'Any movements known to cause discomfort; any movements know to ease discomfort' (P10 SP)* *Irritability, response to exercise, diagnosis. (P6 Ph)*		**Subtheme: Understanding my back pain; COM-B Psychological capability** *'It comes and goes; I am sure the effect of the seasons on it and weather patterns and things.' (S3 Pool swimmer)*	length of time with LBP and the subtheme, *more than just back pain*, discussed the impact on mobility supporting the inclusion of these domains in the questionnaire. The subtheme, *understanding my back pain*, discussed specific advice received from a health professional about their back pain, the subtheme, *how I manage my back pain*, included discussion regarding current coping strategies, and whether they push hard or are cautious with exercise supporting the inclusion of these domains in the questionnaire. 31.3% of participants agreed that they were worried that swimming would make their LBP worse but 50.6% agreed that they believed that swimming would be a good form of exercise for their back, the subtheme, *my swimming journey*, discussed how people had tried swimming with the expectation that it might be beneficial for LBP, supporting the need to ask	Does their back pain impact their mental health? What have you tried already; did it help? What did your health professional recommend? Have you received any advice about being cautious about certain activities? Do they have low bone density? Are you someone who tends to avoid or push too hard with exercise? How is your back after exercise? What are your aims and goals attending this swimming programme, e.g., to reduce pain, improve fitness, manage a healthy weight? **COM-B: Physical and psychological capability and reflective motivation**
Code: How long (AP) (How long have they had their LBP) *'How long has it been going on?' (P9 LBP)*	Median number of years with back pain 10.5 years	**Subtheme: How my back pain started; COM-B Physical and psychological capability** *'Historically I have had back issues since about 21, on and off.' (S2 Pool swimmer)*		
Code: Mobility (AP) (How mobile is their back, arms, and legs *'Is it affecting movement of arms and legs and mobility in general? (P16 SP)*		**Subtheme: More than just back pain; COM-B Physical and psychological capability** *'I am not sure that I have back pain so much as I have discomfort and lack of mobility in my lower back which sometimes manifests as pain if I overdo it... So, most of the time my back is just grumpy.' (S1 Outdoor swimmer)*		

Code: Advice (AP) (Have they received specific advice about their LBP) *'What they have been recommended by medical professionals' (P11 SP)* *Current activity levels and "baselines"* *Participants tendency to avoid or push through Participants expectation of swimming How it fits their values and goals (P8 Ph)*		**Subtheme: Understanding my back pain; COM-B Psychological capability** *'We just go to the chiropractor every three months for maintenance so if there is anything a bit out of tilt, where I have been swimming just on one side, if I am just a bit out of alignment then he will re-correct that and I have found that very beneficial as well.' (S4 Pool and outdoor swimmer)* *'The surgeons that I have seen have said avoid all impact work so obviously the pool was the obvious answer.' (S14 Pool swimmer)* *'The consultant said you will never run again but you can swim or cycle.' (S13 Outdoor swimmer)*	about expectations of swimming in the questionnaire. When mapped onto the COM-B model the back pain questions would related to the physical and psychological capability, physical, and reflective motivation dimensions and the intervention function would be enablement.	**BCW Intervention function Enablement**
Code: Strategies (AP) (What have they tried already, and did it help?) *'Current coping strategies' (P15 Ph)*		**Subtheme: How I manage my back pain; COM-B Physical and psychological capability** *'Yes, I occasionally take painkillers if I am trying to sleep, and it is painful; that is*		

		only if it is really bad. I try not to take too much of that just because it would have less of an impact.' (S11 pool swimmer) *'With going to a chiropractor for regular three-monthly appointments.' (S4 Pool and outdoor swimmer)*		
Code: Avoid or push too hard (IV) (Are they someone who pushed too hard with exercise or avoids exercise) *'Participant's tendency to avoid or push through' (P8 Ph)*		**Subtheme: How I manage my back pain; COM-B Physical and psychological capability** *'So, I am not sedentary, so I probably push it and I ride bikes and I do fall off bikes.' (S1 Outdoor swimmer)* *'I can't just go down there and do the minimal amount; I have to put a shift in.' (S4 Pool and outdoor swimmer)* *'You get in and you push yourself. Today I have done 40 lengths and you might say only 40, but that's good. I could do more, but I know when to stop.' (S8 Pool swimmer)*		

		'I have to be careful, so I also have to make sure that I listen to my body.' (S9 Outdoor swimmer)		
Code Expectations (IV) (What are their expectations of swimming) *'Participant's expectations of swimming, how it fits with values or goals' (P8 Ph)*	**Barriers:** 31.3% agreed that they were worried that swimming would make their LBP worse; **COM-B Psychological capability** **Enablers:** 50.6% agreed that they believe that swimming is good for their back, and this would encourage them to swim: **COM-B Reflective motivation** 38.3% agreed that experiencing less LBP in the pool would encourage them to swim; **COM-B Physical capability** 23.5% agreed finding that swimming eased their LBP would encourage them to swim; **COM-B Physical capability**	**Subtheme: My swimming journey; COM-B Physical and psychological capability and physical and social opportunity** *'When I was with my physio with the NHS, they told me that swimming might be good for my back not only that I can do it, but it might be good for my back, so I was actually recommended it.' (S11 Pool swimmer)* *'I just kind of felt it was going to be gentle support for my back.' (S10 Outdoor swimmer)*		
Swimming ability and experience				
Code: Ability (AP) **COM-B Physical capability**	52.4% were able to swim 50m or more **Barrier:**	**Subtheme: My swimming journey; COM-B Physical and psychological capability and**	**Convergence** Six a priori codes and one in vivo code were used and	**The following pre-programme information**

(Can they swim unaided; how far can they swim without stopping) *'Can they swim unaided?' (P3 SP)* *G.H issues, previous swimming experience, any inherent phobias or concerns, views as to the meaning of pain. (P15 Ph)*	31.7% agreed that not swimming well was a barrier to swimming; **COM-B Physical capability**	**physical and social opportunity** *'I am not really a very strong confident swimmer. For me to get in the water was a feat by itself, I wouldn't get my hair wet, and I wasn't really keen on going out of the water.' (S9 Outdoor swimmer)* *'So, what I have found, being a competitive swimmer, I have been, I have found that I would like to do all strokes but know that there is a limit to how far I can go with strokes.' (S2 Pool swimmer)* *'I swum as a child, I swam at nearly pro level.' (S5 Pool and outdoor swimmer)*	developed to analyse the data from the round one survey to guide the questions about swimming ability and experience: '*ability', 'swimming strokes', 'aquatic breathing', 'entries and exits', 'phobias', 'recent swimming', and 'temperature.'* When the data was integrated from study one and two the data was congruent based upon the barriers and enablers data from study one and the subthemes, *my swimming journey, learning to swim with back pain, my barriers to swimming and how I overcome them, how swimming looks for me, and where I swim.* Study one had identified that 52.4% of participants were able to swim 50m or more and 31.7% agreed that not swimming well was a barrier to swimming, the subtheme, *my swimming journey*, illustrated the range of swimming abilities amongst swimmers. The theme, *learning to swim with back pain*, included the different	**was suggested in the round two survey** **Swimming ability and experience questions** *(One length of a pool is usually 25 metres)* Can you swim aided? How far could you swim without stopping? (in metres) What is your preferred stroke for your back? Can you swim front crawl? Can you swim backstroke? Can you swim breaststroke? Do you swim any other stroke? If so which stroke? Are you comfortable in deep water and can you tread water? Can you put your face in the water and breathe out?
Code: Swimming strokes (AP) (What is their preferred stroke for their back? Is there a stroke that makes their back pain worse? Can they swim front crawl, backstroke, breaststroke other strokes?)		**Theme: Learning to swim with back pain; COM-B Physical and psychological capability and physical and social opportunity** *'But the whole action of breaststroke I don't think lends itself to back pain either really.' (S13 Outdoor swimmer)*		

Is there any stroke that makes their back pain worse? (P16 SP)			strokes people found helpful or not so helpful for LBP and the skills, such as aquatic breathing required when swimming; supporting the need to ask about swimming ability, strokes, and aquatic breathing. 29.3% of participants agreed that it would be difficult to get in and out of the pool, supporting the inclusion of a question about whether a person can enter the water without assistance and what help they would require. 18.3% agreed that they have a fear of water and the subtheme, *my barriers to swimming and how I overcome them*, illustrated that even regular swimmers have fears about swimming. 25.6% of people had been swimming in the last month in study one, supporting the need to ask when they last went swimming. 23.5% agreed they a cold swimming pool was a barrier to swimming and the subtheme, *where I swim*, also discussed water temperature	Would you normally use goggles to swim? Can you enter and exit the water without assistance? If you can't what help will you require? Can you float unaided? Do you have any phobias or worries about swimming or being in water, have you ever had a bad experience in water? (yes/no/ please comment) When was the last time you swam? How often have you swum in the last few months? Have you had swimming lessons as an adult? How do you feel in warmer and colder water, what temperature is best for you? **COM-B: Physical and psychological capability**
Code: Aquatic breathing (AP) (Can they put face in water and breathe out, do they normally use goggles to swim) *'Are they able to put their head in the water? (P3 SP)*		**Theme: Learning to swim with back pain; COM-B Physical and psychological capability and physical and social opportunity** *'I have only just started today to learn to how to put my face in the water in the swimming pool that is over a year on'. (S9 Outdoor swimmer)*		
Code: Entries and exits (AP) COM-B Physical capability (Can they enter the water without assistance? If they can't what help will they require?) *'Can they manage to get in and out of the pool unaided (P9 LBP)*	**Barrier:** 29.3% agreed that it would be difficult to get in and out of the pool; **COM-B Physical capability**			
Code: Phobias (AP) Do they have any phobias or worries about swimming or being in the water, have they had a bad experience in the water? *'Any phobias (P1 SP)*	**Barrier:** 18.3% agreed that they have a fear of water; **COM-B Psychological capability and automatic motivation** 44.5% agreed they felt uncomfortable wearing a swimming costume or	**Subtheme: My barriers to swimming and how I overcome them; COM-B Physical and psychological capability** *'I still have a bit of a phobia of being claustrophobic in the water. So, I am constantly*		

	trunks; **COM-B Psychological capability and automatic motivation**	*overcoming lots and lots of fears.' (S9 Outdoor swimmer)*	preferences for people with LBP, supporting the inclusion of a question asking about preferred water temperature. When mapped onto the COM-B model the swimming ability questions related to the physical and psychological capability and physical and social opportunity dimensions and the intervention function would be enablement.	**and physical and social opportunity** **BCW Intervention function Enablement**
Code: Recent swimming (AP) (When was the last time they swum, how often have they swum in the last few months?) *'How often they have swum in the recent months/ years (P7 SP)*	25.6% had been swimming in the last month	**Theme: How swimming looks for me; COM-B Physical and psychological capability Physical and social opportunity** *'At the moment I go 4 or 5 mornings, and it is about 40 minutes and Wednesday evening for an hour.' (S3 Pool swimmer)*		
Code: Temperature (IV) (How do they feel in warmer and colder water, what temperature is best for you?) *'Water temperature' (P11 SP)*	**Barrier:** 23.5% agreed that they found the swimming pool too cold; **COM-B Physical opportunity**	**Subtheme: Where I swim; COM-B Physical opportunity** *'When I go to Bannatynes and it is lovely and boiling and I can almost get in without doing a warm up.' (S3 Pool swimmer)* *'If my back is really bad, I don't really care if it is minus whatever I have swum in the sea even if it is 5 or 6 degrees, I love it.' (S9 Outdoor swimmer)*		

Delivery of programme				
Study three Round one QUAL	**Study one QUAN**	**Study two QUAL**	**Meta inferences, interpretations, and COM-B and BCW analysis**	**Study three Round two QUAN**
Code: Physiotherapist (AP) (Reference to a physiotherapist trained in aquatic therapy) *'Ongoing drop in facility led by a physiotherapist, subsidised access to a pool'.* (P6 Ph) *'For those with a serious condition perhaps a referral from a physician or physio'* (P14 LBP)	**Barrier:** 31.3% agreed that they were worried that swimming would make their LBP worse; **COM-B Psychological capability** **Enabler:** 78.1% agreed that they were more likely to go swimming if their health professional had advised them to swim; **COM-B Reflective motivation**	**Subtheme: My swimming journey; COM-B Physical and psychological capability, Physical and social opportunity** *'When I was with my physio with the NHS, they told me that swimming might be good for my back not only that I can do it but it might be good for my back, so I was actually recommended it.' (S11 Pool swimmer)*	**Complimentary** Three a priori codes were used to analyse the data from the round one survey to guide the delivery of the programme: '*Physiotherapist', 'swimming professional'* and *'expert patient'*. When the data was integrated from study one and two new insights were observed based upon the barriers and enablers data and the subthemes, *my swimming journey, my barriers to swimming and how I overcome them, and my swimming community*. The barriers data had identified that 31.3% of participants were worried that swimming could make their LBP worse, and the enablers data had found that 78.1% agreed that they were	**The following delivery of the programme was suggested in the round two survey** A physiotherapist trained in aquatic therapy A level 2 swimming teaching or coach with experience teaching adults A collaboration by which both a physiotherapist and swimming teacher or coach lead the sessions. A collaboration by which a person with low back pain who has already completed the programme joins the swimming teacher / coach or physiotherapist leading the session.
Code: Swimming professional (AP) (Reference to a swimming professional) *'Working with one swimmer at a time allows a better understanding between coach and swimmer it also allows for teacher in the*	9.8% has had swimming lessons as an adult 52.4% were able to swim 50m or more. **Barriers:** 14.8% agreed that they found that their LBP was worse while swimming; **COM-B Physical capability**	**Subtheme: My barriers to swimming and how I overcome them; COM-B Physical and psychological capability** *'I had a couple of lessons with a teacher, near Bodium in the river, and she was teaching me a better breaststroke. So really going down into the water and up and she was*		

water to demonstrate/assist if required.' (P2 SP)		*saying if you are swimming above the water the whole time it is really bad for you, it will strain your back so yes I would say that I am quite careful about really following, I have her words in my mind that I really focus on my stroke.' (S10 Outdoor swimmer)* *'I took lessons to improve my swimming. I have never been able to front crawl or anything like that so I can do that now, I put my head under the water when I swim. I do it all correctly now. It is an achievement for me at my age.' (S8 Pool swimmer)* *'I could swim, but I got some proper technical lessons, a teacher who could adapt to the way that my body works.' (S6 Pool and outdoor swimmer)*	more likely to go swimming if their health professional had advised them to swim supporting the need for physiotherapy support. The barriers data had also found that 14.8% had agreed that they found that their LBP was worse while swimming, 9.8% had swimming lessons as an adult and 52.4% were able to swim 50m or more, supporting the need for swimming professional support. The subtheme, *my swimming journey*, included a discussion of recommendation of swimming by a physiotherapist and the subtheme, *my barriers and how I overcome them*, included discussion about how involving a swimming professional enabled a better swimming technique and less LBP during swimming, supporting the inclusion of both a physiotherapist and swimming professional in the delivery of the programme. The subtheme, *my swimming community*, included	**COM-B Physical and psychological capability** **BCW Intervention function Modelling, enablement, education, and training**
Code: Expert patient (AP) (Reference to an expert patient leading or assisting) No reference		**Subtheme: My swimming community; COM-B Social opportunity** *'I work with a charity called mental health swims, which run all around the country for*		

		people who have been struggling and are using the water to help them with their mental health.' (S10 Outdoor swimmer) *'I would always recommend it to people because I do it, but there is not enough done in that respect…. But I always if anyone has back pain, I say try and have a swim, you will feel better for it.' (S13 Outdoor swimmer)* *'I want to be able to help other people with, I want to make sure that I help myself first.' (S9 Outdoor swimmer)*	discussion about how swimmers with LBP recommended swimming to other swimmers and supported new swimmers as part of a mental health charity, supporting the inclusion of an expert patient in the delivery of the programme. When mapped onto the COM-B model the delivery of the programme related to the physical and psychological capability dimensions and the intervention functions would be modelling, enablement, education, and training.	

Teaching / coaching approach				
Round one QUAL	**Study one QUAN**	**Study two QUAL**	**Meta inferences, interpretations, and COM-B and BCW analysis**	**Study three Round two QUAN**
Code: Subgrouping back pain (AP); COM-B Physical and psychological capability (An approach that takes into account the different types of back pain, that may respond differently to different swimming strokes and programs) *'With severe back pain body position will need to be carefully looked at and it may be best with no arms just legs for those who suffer severe pain.'* (P16 SP)		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'With the initial injury it actually made it a bit worse. I found that the position that I was in in the water when swimming on my front wasn't good. The only way that I could swim comfortably was on my back.' (S14 Pool swimmer)*	**Convergence and Complimentary** Seven a priori codes were used to analyse the data from the round one survey to guide the teaching or coaching approach: '*subgrouping back pain', 'increasing physical activity and fun', 'kinaesthetic', 'constructivist', 'technical / instructional', 'visual' and 'exercise and training*.' When the data was integrated from study one and two some of the data was congruent and new insights were observed based upon the data from the barriers and enablers data and the subthemes, *how I swim with back pain, my goals and motivation, my barriers and how I overcome them, and my training regime*. The subtheme, *how I swim with back pain*,	**The following teaching and coaching approaches were suggested in the round two survey** An approach that takes into account the different types of back pain, that may respond to differently to different swimming strokes and programs **COM-B Physical capability** **BCW Intervention function Training and enablement** An approach that focuses on swimming being used to increase levels of physical activity, making swimming fun with less focus on swimming as a form of exercise and less concern about technique **COM-B Physical and social opportunity**
Code: Increasing physical activity and fun (AP); COM-B Physical and Social opportunity (An approach that focuses on swimming	**Barrier:** 32.1% agreed that they don't enjoy swimming; **COM-B Automatic motivation**	**Subtheme: My goals and motivation; COM-B Reflective and automatic motivation** *'We just here for fun, we just do this for fun!' (S9 Outdoor swimmer)*		

being used to increase levels of physical activity, with less focus on swimming as a form of exercise and less concern about technique) *'Use hybrid strokes to get people moving' (P1 SP)*	**Enablers:** 92.6% agreed that they would like to use swimming to improve muscle strength and flexibility; **COM-B Reflective motivation** 89.7% agreed that they would like to use swimming to help maintain a healthy weight or lose weight; **COM-B Reflective motivation** 89.4% agreed that they would like to use swimming to improve their fitness and general health; **COM-B Reflective motivation**	*'Keeping my fitness up, keeping my stamina up, because that is something you lose quite quickly, it's knowing that if I wanted to swim 3K I could got out and swim 3K, I have got that ability to do that.' (S2 Pool swimmer)*	included discussion about the different swimming strategies people used based upon their LBP diagnosis, supporting a subgrouping approach to delivering the programme. The subtheme, *my barriers and how I overcome them*, discussed strategies that the participants used to overcome barriers, this supported the delivery of a constructive approach whereby the swimmer actively constructs what they learn, they problem solve, and the teacher facilitates their learning. 14.8% of participants agreed that they found their LBP was worse while swimming and subtheme, *how I swim with back pain*, discussed adaptations to swimming based upon how their back felt whilst swimming, reducing discomfort whilst swimming. These findings supported delivering a kinaesthetic approach whereby participants consider how their body feels	**BCW Intervention function Enablement** A kinaesthetic approach wh ereby participants consider how their body feels when they are swimming and make changes to their stroke based upon how they feel **COM-B Physical and psychological capability** **BCW Intervention function Education, training, and enablement** A constructivist approach whereby the swimmer actively constructs what they learn, they problem solve, and the teacher facilitates the learning experience **COM-B Physical and psychological capability** **BCW Intervention function Education, training, and enablement** A technical approach aiming at improving swimming technique
Code: Kinaesthetic (AP); COM-B Physical and psychological capability (An approach whereby the participants consider how their body feels when they are swimming and	**Barrier:** 14.8% agreed that they found that their LBP was worse while swimming; **COM-B Physical capability**	**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'I will almost lift my lower back and drop my legs because after a while if I do get in the same position for too long and relaxed, I do tend to arch and that, it*		

makes changes to their stroke based upon how they feel) *'I think you naturally adjust your own strokes to fit your comfort and ability, that's what I did!'* (P9 LBP)		*doesn't necessarily cause pain but it is just uncomfortable.' (S14 Pool swimmer)*	when they are swimming, and they make changes based upon how they feel. Study one had identified that 52.4% of participants were able to swim 50m or more and subtheme, *my barriers and how I overcome them*, discussed how having lessons was a helpful tool when learning to swim with LBP, supporting a technical or instructional approach to swimming, whereby the aims is to improve swimming technique. The subtheme, *my barriers and how I overcome them*, discussed how video feedback had been a helpful tool for developing swimming technique, this wasn't mentioned by the participants in round one. The enablers data identified that the wider benefits of swimming were common enablers for people with LBP and the subtheme, *my training regime*, discussed how motivational tools such as watches could direct training, supporting an	**COM-B Physical and psychological capability** **BCW Intervention function Education, training, and enablement** A visual approach including demonstrations and video feedback
Code: Constructivist (AP); COM-B Physical and psychological capability (An approach whereby the swimmer actively constructs what they learn, they problem solve, and the teacher facilitates the learning experience) *'Facilitate participants to learn when things don't go to plan, adjust and re-evaluate...core skills in managing chronic pain related to problem solving.'* (P8 Ph)		**Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability** *'I got some proper, I could swim, but I got some proper technical lessons, a teacher who could adapt to the way that my body works. I still have real problems firing that left glut so I very rarely ever kick that side. And that is why I started swimming.' (S6 Pool and outdoor swimmer)*		**COM-B Physical and psychological capability** **BCW Intervention function Education, training, and enablement** An approach that focuses on swimming as a form of exercise and training, encouraging swimmers to monitor progress and set goals **COM-B Physical and psychological capability** **BCW Intervention function Education, training, and enablement**
Code: Technical / Instructional (AP); COM-B Physical and	52.4% of participants were able to swim 50m or more	**Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability**		

psychological capability (An approach aiming to improve swimming technique) *'Moving in a streamline way, breathing correctly' (P6 Ph)*	**Barrier:** 31.7% agreed that they can't swim very well; **COM-B Physical capability**	*'He (the coach) has changed my head position and I wonder if that has helped with the discomfort, the pain but the fact that I can swim for longer on front crawl. And I had thought that it was just the breathing but now I am thinking about it in relation to this maybe I am physically more comfortable doing it. That the way I breathe and where my head is different, and I am less humped over' (S3 Pool swimmer)* *'I ought to get my technique a bit better so that I don't shift from having a sore back to then having a sore shoulder.' (S1 Outdoor swimmer)* *'I have never been able to front crawl or anything like that so I can do that now, I put my head under the water when I swim. I do it all correctly now.' (S8 Pool swimmer)* *'By putting so much pressure from the top of the spine, the middle of the spine and holding myself stiff and not actually having a very good technique.' (S9 Outdoor swimmer)* *'I definitely want to get some lessons where I can become a stronger swimmer.' (S10 Outdoor swimmer)*	approach that focused on swimming as a form of exercise and training, encouraging swimmers to monitor progress and set goals, again this wasn't mentioned by the participants in round one. The barriers data had identified that 32.1% of participants agreed that they don't enjoy swimming and the subtheme, *my goals and motivation,* discussed how they found swimming enjoyable, and the fun and enjoyment enabled regular swimming, supporting the need for a more enjoyable and fun approach when delivering the programme. When mapped onto the COM-B model the delivery of the programme related to the physical and psychological capability, physical and social opportunity dimensions and the intervention functions would be enablement, education, and training.	

		'I could swim, but I got some proper technical lessons, a teacher who could adapt to the way that my body works.' (S6 Pool and outdoor swimmer)		
Code: Visual (AP); COM-B Physical and psychological capability (A visual approach including demonstrations and video feedback) No reference		**Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability** *'To me it feels like I am completely looking forwards at a diagonal angle, but I am not, on the video I can see that I am actually just turning it.' (S3 Pool swimmer)*		
Code: Exercise and training (AP); COM-B Physical and psychological capability (An approach that focuses on swimming as a form of exercise and training, encouraging swimmers to monitor progress and set goals) No reference	**Enablers:** 92.6% agreed that they would like to use swimming to improve muscle strength and flexibility; **COM-B Reflective motivation** 89.7% agreed that they would like to use swimming to help maintain a healthy weight or lose weight; **COM-B Reflective motivation** 89.4% agreed that they would like to	**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** *'I train with an apple watch so that does my lengths, tracks the time and I keep all my stats on Strava… It certainly was during my charity swim; it is quite nice to be able to see. Also, the tracking of fitness levels and times and everything like that; it is all in one place so I can do it straight from my app on my phone. With Strava I was able to map it with lots of other things that I was doing. So was I working harder on my bike or walking or whatever.' (S14 Pool swimmer)*		

	use swimming to improve their fitness and general health; **COM-B Reflective motivation**			

Session brief				
Study three Round one QUAL	**Study one QUAN**	**Study two QUAL**	**Meta inferences, interpretations, and COM-B and BCW analysis**	**Study three Round two QUAN**
Code: Rehabilitation tool (AP); COM-B Psychological capability and reflective motivation (Explain why swimming is being used as a rehabilitation tool) *'I think it's important to explain the aims and research behind it. Maybe that it's a long process and improvement may not be seen instantly.'* (P12 LBP)			**Convergence** The following four a priori codes were used to analyse the data from the round one survey to guide the content of the session brief: '*rehabilitation tool', 'concerns', 'what to expect', and 'standard pre-swimming safety brief'*. The following four a priori codes were used to analyse the data from the round one survey to guide the content of the session brief: '*rehabilitation tool', 'concerns', 'what to expect', and 'standard pre-swimming safety brief'*. The participants agreed that it could be	**The following session brief was suggested in the round two survey** Explain why using swimming as a rehabilitation tool**,** the benefits, and problems with this type of approach and any guidelines. Include some discussion about not knowing which swimming stroke is best for back pain. Hopefully by the end of the class the swimmers will have developed a better understanding of what stroke(s) are best for their back. Also talk about
Code: Concerns (AP); COM-B Psychological capability (Discussing concerns, fears, and barrier; in relation to back pain, swimming or being in the water)	**Barrier:** 44.5% agreed that they felt uncomfortable wearing a swimming costume; **COM-B Psychological capability and Automatic motivation**	**Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability**		

'Yes, I believe back pain is strongly related to the biopsychosocial model and as such discussing the participants possible fears and apprehensions will be beneficial to help participants feel more at ease and ready to exercise.' (P10 SP)	31.3% agreed they were worried that swimming would make their LBP worse; **COM-B Psychological capability**	*'I just have to be really careful that it doesn't go again. So, there is always that kind of fear in the back of my mind that it will happen.' (S10 Outdoor swimmer)*	helpful to discuss the session plan with the swimmers before they get in the water. The suggestions included standard swimming session brief and additional information specific to this population. When the data was integrated the findings were congruent based upon the barriers and enablers data from study one and the subtheme, *my barriers and how I overcome them,* from study two. The barriers data had identified that 44.5% of the participants felt uncomfortable wearing a swimming costume and 31.3% agreed that they were worried that swimming would make their LBP worse and the enablers data that 50.6% of participants believed that swimming is good for their back. The subtheme, *my barriers and how I overcome them,* from study two included discussion of barriers and methods of overcoming barriers. The integration of	the wider benefits of swimming such as impact on weight and mental health and how this could help in the management of their back pain. **COM-B Psychological capability and reflective motivation** **BCW Intervention function Education** Discuss any concerns, fears, and barriers**;** in relation to back pain, swimming or being in the water **COM-B Psychological capability** **BCW Intervention function Education** Discuss what to expect and what is normal during and after a swim. They might experience some discomfort, mild shortness of breath and muscle fatigue; they should alert the teacher if they experience a significant increase in back pain or they feel unwell. Discuss pacing and when they should rest
Code: What to expect (AP); COM-B Psychological capability (Discussing what to expect, what is normal during and after a swim, pacing and expectations) *'Yes, initially it will help with relaxation if the participant knows what to expect and any issues can be discussed and altered straight away.'* (P7 SP)	**Barrier:** 31.3% agreed that they were worried that swimming would make their LBP worse; **COM-B Psychological capability** 14.8% agreed that they found that their LBP was worse while swimming: **COM-B Physical capability** **Enabler:** 50.6% agreed that they believe that swimming is good for their back, and this would encourage them to swim; **COM-B Reflective motivation** 38.3% agreed that experiencing less LBP in the pool would encourage them to swim; **COM-B Physical capability**			

	23.5% agreed finding that swimming eased their LBP would encourage them to swim; **COM-B Physical capability**		the data supported including a discussion about concerns, fears, and barriers and what to expect during the session and the round one survey data supported discussion about swimming being used as a rehabilitation tool and a standard pre-swimming safety brief. When mapped onto the COM-B model the session brief related to the psychological capability and reflective motivation dimensions and the intervention function from the BCW would be education.	/pause between activities or lengths. Discuss their expectations; what do they want to achieve from the session **COM-B Psychological capability** **BCW Intervention function Education** It is assumed that the following would be included prior to any swimming class; safety information, housekeeping, water temperature, depth, safety procedures, register changes in health, back pain and wellbeing, are they well hydrated and when did they last eat. How to enter and exit water and summon help. Introduction to the type of session, session plan, which strokes, aims, objectives and the time the session will run. **COM-B Psychological capability** **BCW Intervention function Education**
Code: Standard pre-swimming safety brief (AP); COM-B Psychological capability *'Include usual housekeeping and what to do in emergencies etc.'* (P8 Ph)				

Session debrief				
Study three Round one QUAL	**Study one QUAN**	**Study two QUAL**	**Meta inferences, interpretations, and COM-B and BCW analysis**	**Study three Round two QUAN**
Code: Expectations (IV); COM-B Psychological capability (What to expect after the session, for example post exercise soreness, fatigue) *'Explain how the person might feel afterwards and how to deal with it. e.g., focus on the breath.' (P13 LBP)*	**Barriers:** 21.0% agreed that they found that their LBP was worse after swimming; **COM-B Physical capability** 14.8% agreed that they found that their LBP was worse while swimming; **COM-B Physical capability** **Enablers:** 38.3% agreed that experiencing less LBP in the pool; **COM-B Physical capability** 23.5% agreed finding that swimming eased their LBP; **COM-B Physical capability**		**Convergence** The following five in vivo codes were developed to analyse the data from the round one survey to guide the content of the session debrief: *'expectations', 'teaching points', 'positive feedback', 'what to work on'* and *'reflection'*. When the data was integrated from study one the findings were congruent based upon the barriers data. The barriers data had identified that 21% of participants had agreed that they found that their LBP was worse after swimming and the enablers data identified that 23.5% agreed that swimming eased their LBP. The integration of the data supported the inclusion of expectations during the session debrief and the data from the round one survey	**The following session debrief was suggested in the round two survey** Explain how the person might feel afterwards and how to deal with it. Flare up of pain, advice / reassurance, and safety netting. **COM-B Psychological capability** **BCW Intervention function Education** Cover any teaching / coaching points that were difficult to communicate while they were in the water or as a group. What could they adjust or adapt in the next session. **COM-B Physical and Psychological capability** **BCW Intervention function Education and training**
Code: Teaching points (IV); COM-B Physical and Psychological capability (Teaching or coaching points that could be reviewed or were too difficult to communicate when the water or in a group)				

'Any coaching info that was difficult to communicate whilst in the water or part of a larger group.' (P14 LBP)			supported the inclusion of teaching points, positive feedback, what to work on before the next session and reflection on the session. When mapped onto the COM-B model the session debrief related to the psychological and physical capability and reflective motivation dimensions and the intervention functions would be education and persuasion.	Positive feedback from teacher / coach. Finish with a reflection on achievements, not problems. **COM-B Reflective motivation and Psychological capability** **BCW Intervention function Education and persuasion** What to work on before the next session? Goals for the following week? Motivational tools they could consider? What will be covered in the next session. Dryland exercises they could try this week. Do they need any equipment next week? **COM-B Psychological capability** **BCW Intervention function Education** Reflection on class, general feedback from swimmer. What they expected versus what they achieved during session? How it felt, was any of the session
Code: Positive feedback (IV); COM-B Reflective motivation and Psychological capability (Positive feedback and achievements) *'Focus on achievement, not on problems.' (P15 Ph)*				
Code: What to work on (IV); COM-B Psychological capability (What can they work on during their next session or between sessions) *'Things to work on, dry land exercises to continue until next session.' (P4 Ph)*				
Reflection (IV); COM-B Reflective motivation and psychological capability (Reflection on achievements and progress) *'Reflections on class, what they expected vs what they achieved. Learnings and discussion on what they need*				

to adjust/adapt in next session.' (P8 Ph)				uncomfortable for their back, do they have any concerns? What went well, what did they enjoy, what was more challenging, what did they dislike? What stroke(s) were best for their back in this session? How are they feeling physically and psychologically? Relate to key values or goals. **COM-B Reflective motivation and psychological capability** **BCW Intervention function Education and persuasion**

Warm up				
Study three Round one QUAL	**Study one QUAN**	**Study two QUAL**	**Meta inferences, interpretations, and COM-B and BCW analysis**	**Study three Round two QUAN**
Code: Water based (AP); COM-B Physical capability (Water based warm up) *'I would warm up in the water, so body weight supported.' (P4 Ph)*		**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** *'I tend to do it all in the water. So, I will do a gentle warm-up of about 8-10 lengths…I find that I get better movement in*	**Convergence** Seven a priori codes were used, and two in vivo codes were developed to analyse the data from the round one survey to guide the content of the warmup: '*water based', 'dryland warm up', 'both water and dryland*	**The following warm up was suggested in the round two survey** Awareness activities including getting used to the sensation of the water and the feeling of weightlessness, how does

		the water. So, I find it more comfortable doing stretches in the water.' (S12 Pool swimmer) *'I normally warm up and do 2 lengths of front crawl and after that I do ½ a length of breaststroke and then go on to the front crawl and then repeat.' (S7 Outdoor)*	*warm up', 'lack of evidence', 'mind-body exercise', 'core aquatic skills', 'stretches', 'low intensity swimming'* and '*exercise to raise the heart rate*.' When the data was integrated from study two the findings were congruent, based upon the subtheme, *my training regime.* This subtheme included discussion about warmups used in the water and on dryland before swimming, incorporating low intensity swimming, stretches in the water, and home back exercises before swimming. Not all swimmers did a warmup but reflected that maybe they should consider doing one. The integration of the data supported the inclusion of low intensity swimming, and stretches, and the data from the round one survey supported the inclusion of awareness activities, walking in the water, relaxation, floating and sculling and light jogging.	this impact on movement and breathing. Feeling the sensation of their spine lengthening when moving through water. Bringing an awareness to their breathing using techniques and exercises. Acclimatisation to the water temperature, if the session is in different settings feeling what water temperature is best for their back. **COM-B Physical and psychological capability** **BCW Intervention function Education and training** Relaxation, floating and sculling Also see core aquatic skills section **COM-B Physical and psychological capability** **BCW Intervention function Education and training** Stretches in the water for back, neck, arms, and legs, including usual physio
Code: Dryland warm up (IV); COM-B Physical and psychological capability (Advice against a dryland warm up) *'Warmups on dryland IMHO are incorrect for these swimmers due to the teachers restricted medical knowledge. In the water with the buoyancy effect removing some of the backs weight loading and the water density giving some lateral buoyancy effect and the resistance working muscle groups.' (P2 SP)* *'I would prefer to get straight in especially if I was a little*		**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** *'I warm up my back before swimming. At home I roll my legs side to side and practice the cat cow stretch and when I get to the pool, I warm up my shoulder.' (S4 Pool and outdoor swimmer)* *'But I think especially swimmers, they know that they should warm up but they don't.' (S2 Pool swimmer)*		

anxious about the session!' (P9 LBP)			When mapped onto the COM-B model the session brief related to the physical and psychological capability dimensions and the intervention functions would be education and training.	stretches. Finding out whether it is better for back to do stretches when they first get in pool or after some low intensity swimming. **COM-B Physical capability** **BCW Intervention function** **Education and training** Start with easy / low intensity swimming (front crawl and backstroke), gradually increasing intensity. Finding out whether it is better for them to warm up alternating strokes or with just one stroke. **COM-B Physical capability** **BCW Intervention function** **Education and training** Walking in the water, different directions, different speeds, with or without floatation aids, walking while doing sculling movements with arms. Light jogging in the water. **COM-B Physical capability**
Code: Both (AP); COM-B Physical capability (A combination of both a water based and dryland warm up) *'Depends on the person. Some stretching prior to going into water can help. I do 40/60 minutes of yoga and/or Pilates every day so have always warmed up muscles before going swimming. I still like to warm up in water by walking, jogging, or jumping in the water before swimming to get used to the temperature and get my "swimming breathing" going. I think getting the breathing right is very important as it not only helps aerobic ability but helps manage pain'. (P13 LBP)*		**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** *'It is going to be after 5 minutes of stretching on the side. I stretch my back; I put my hand up and stretch to the left and to the right. A little bit of trying to reach my ankles. Hands and the legs and then going into the water and the warmup would be anything between 200m to 400m.' (S5 Pool and outdoor swimmer)* *'It tends to take me quite a long time, maybe 800m before I feel like I can do a breaststroke. Because I have got the bit of your back arch going and the dodgy knees, but mainly my back doesn't feel like it wants to go that way.' (S3 Pool swimmer)*		
Code: Lack of evidence (IV); COM-B Psychological capability		**Subtheme: My training regime** **COM-B: Physical and psychological capability,**		

(Lack of evidence for using a warmup) *'Unnecessary, I think. Not aware evidence is strongly in support of warmups, but many expect them so could be some gentle movement in the water. Standing around on the poolside might make people who lack body confidence embarrassed and add to stigma' (P8 Ph)*		**Physical and social opportunity** *'No, Should, no I don't really. Often it is fitting a swim in around everything else, because I have switched priorities, I make sure that I get that swim… So often it is time efficient, so I just get in' (S10 Outdoor swimmer)* *'No, I haven't ever done that.' (S8 Pool swimmer)* *'No, no I should do, shouldn't I?' (S6 Pool and outdoor swimmer)*		**BCW Intervention function Education and training**
Code: Mind body exercise (AP); COM-B Physical and psychological capability (Any form of mind body exercise) *'Awareness activities (of breathing and also of sensations of water etc)' (P8 Ph)*				
Code: Core aquatic skills (AP); COM-B Physical and psychological capability				

(Any activity that is considered a core aquatic skill) *'Poolside breathing exercises to calm and relax them. These breathing exercises to continue into the pool with some floating on the back' (P7 SP)*				
Code: Stretches (AP); COM-B Physical capability (Any activity involving stretching) *'Stretching, not forgetting neck as this holds tension' (P13 LBP)*		**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** *'I do, do a general one, it is not particularly organised one, but it is just to loosen off because I tend to swim first thing in the morning. I do find when I get up my back has obviously been in one position and it just needs a bit of loosening off before I get in, because otherwise I find the first 200m quite uncomfortable so I will do some general loosening off before I get in but nothing specific.' (S14 Pool swimmer)* *'I probably should but I tend to do it all in the water. So, I*		

		will do a gentle warm up of about 8-10 lengths.' (S12 Pool swimmer)		
Code: Low intensity swimming (AP); COM-B Physical capability *'General swimming easy front crawl and back crawl, if not walking, depends on the patient's ability and confidence' (P1 SP)*		**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** *'I normally get in and start off slow and do 200m before I even think about that. But generally, I wouldn't say that is because my back, generally for the health of my body. I don't think it is great getting in and doing exercise at high level straight away. But I think my back would be able to withstand that.' (S11 Pool swimmer)* *'I do 400m just relaxed, no stress freestyle just stretching out slowly and then I will do another 400 and I will throw in a breaststroke length. So, every 4th length will be breaststroke, just so I can start stretching. Long stretching breaststroke just to start, opening up, just stretching all the bits that*		

		need to be stretched.' (S2 Pool swimmer)		
Code: Exercise to raise the heart rate (AP); COM-B Physical capability (Any activity that might raise the heart rate) *'Acclimatisation to the water/pool environment (this could be using social aspects), mobility, gradual increase in intensity to raise heart rate - this could be aerobic base or "easy" swim based on the group' (P10 SP)* *'Walking, jogging, jumping in water to increase heart rate in a supported way' (P13 LBP)*				

Cool down				
Study three Round one QUAL	**Study one QUAN**	**Study two QUAL**	**Meta inferences, interpretations, and COM-B and BCW analysis**	**Study three Round two QUAN**
Code: Stretches (AP); COM-B Physical capability (Any activity involving stretching)			**No data for meta inference** Five a priori codes were used, and one in vivo code was developed to analyse the data from the round one	**The following cool down was suggested in the round two survey**

'Any stretches recommended by physiotherapists to signify the end of a lesson and review the level of pain' (P11 SP)			survey to guide the content of the cool down: '*stretches', 'mind-body exercise', 'core aquatic skills', 'low intensity swimming', 'exercise to lower the heart rate' and 'fun exercises*.' There was no data to integrate from study one or study two for this section; the round one survey data supported the inclusion of stretches, walking in the water, sculling, low intensity swimming and old English backstroke in the cool down. When mapped onto the COM-B model the cool down related to the physical and psychological capability, and automatic motivation dimensions and the intervention functions would be education and training.	Gentle stretches in the water, specific stretches advised by physiotherapist. Do they have more movement now, does the movement feel easier compared to the start of the session? **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Code: Mind body exercise (IV); COM-B Physical and psychological capability (Any form of mind body exercise) *'Love the sound of relaxation floating & focussing on breath!' (P9 LBP)*				Sculling on back with or without breaststroke kick and just kicking. Breathing, relaxation, floating on back, meditation type breathing exercises. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Code: Core aquatic skills (AP); COM-B Physical capability (Any activity considered a core aquatic skill) *'Gentle sculling or just kicking. Floating positions' (P16 SP)*				See core aquatic skills section Easy / low intensity swimming. Changing the stroke from the main set, e.g., if swam on front then would cool down on back.
Code: Low intensity swimming (AP); COM-B Physical capability *'Backstroke normal arms plus double arm backstroke and in some case breaststroke legs' (P3 SP)*				

Code: Exercise to lower the heart rate (AP); COM-B Physical capability (Any activity that might lower heart rate) *'Floating, sculling, and relaxing in the water to slow down the heart rate are great. Meditation type breathing exercises that can be used throughout the day are, for me, one of the most essential tools in managing pain' (P13 LBP)*				**COM-B Physical capability** **BCW Intervention function** **Education and training** Old English backstroke (on back double arm with breaststroke kick) **COM-B Physical capability** **BCW Intervention function** **Education and training** Walking in water and gentle movements with a fun element **COM-B Social opportunity and Automatic motivation** **BCW Intervention function** **Education and training**
Code: Fun exercises (AP); COM-B Social opportunity and Automatic motivation (Any activity which is fun to do) *'Gentle movements using fun with a purpose so that they want to return, regain any oxygen debt' (P2 SP)*				

Core aquatic skills				
Study three Round one QUAL	**Study one QUAN**	**Study two QUAL**	**Meta inferences, interpretations, and COM-B and BCW analysis**	**Study three Round two QUAN**
Code: Coping (IV); COM-B Physical and psychological capability (Learning how to cope with a painful episode while swimming and being able to indicate when they need support or being able to get to side or shallow water independently) *'Learning how to cope with a painful episode when swimming.'* (P6 Ph)	**Barrier:** 14.8% agreed that they found that their LBP is worse while swimming; **COM-B Physical capability**		**Convergence and Complimentary** Seven a priori codes were used, and three in vivo codes were developed to analyse the data from the round one survey to guide the content of the core aquatic skills section: '*coping', 'safety', 'changing position', 'hybrid strokes', 'floating', 'sculling', 'treading water', 'aquatic breathing', 'gliding' and 'awareness exercise'*. When the data was integrated from study one and two some of the data was congruent and new insights were observed based upon the barriers data and the subthemes, *how I swim with back pain, where I swim, my training regime, my barriers to swimming and how I overcome them, and my feelings about swimming*. 14.8% of participants in study	**The teaching of the following core aquatic skills were suggested in the round two survey** Learning how to cope with a painful episode when swimming, being able to indicate when they need support. Being able to get to the side or shallow water independently. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Code: Safety (AP); COM-B Physical and psychological capability (Water safety, how to enter and exit the water, learning to adjust) *'Getting in and out of the water safely is vitally important.'* (P9 LBP)	**Barrier:** 29.3% agreed that they would find it difficult to get in and out of the pool; **COM-B Physical capability**	**Subtheme: Where I swim; COM-B Physical opportunity** *'There's like a fisherman's jetty and there is a bank and over time there are 2 sort of steps that have been worn down. You just step down and there are metal cases filled with stones and you can just kind of tentatively get down and there is a place to hold*		Water safety**,** how to enter and exit the water, learning to make adjustments, trying different methods to reduce discomfort or accommodate for back pain, loss of strength and mobility. This could include

		onto and then you are in.' (S10 Outdoor swimmer)	one agreed that they found that their LBP is worse when	using steps, sliding in, using ramps or hoists.
Code: Changing position (AP); COM-B Physical and psychological capability (Learning how to change position from front to back or from supine to standing) *'Moving to an upright standing position safely'.* (P16 SP)		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'Most people push off; they might not have both feet aligned on the wall and push because they don't have that luxury. Well for me that would cause a lot of pain because you push off perhaps with one leg being slightly out of alignment from the other.' (S7 Outdoor swimmer)* *'I tend to not do tumble turns as often as I used to, I always tend to turn on the same side.' (S2 Pool swimmer)* *'The worst thing with indoor swimming is turning, so obviously pushing off the side when things aren't working very well.' (S6 Pool and outdoor swimmer)*	swimming, supporting the need for including the skill of learning how to cope with a painful episode while swimming. 29.3% of participants agreed that they would find it difficult to get in and out of the pool and the subtheme, *where I swim*, supporting the inclusion of learning entries and exits from the pool. The subtheme, *how I swim with back pain*, discussed difficulties changing position in the water when turning, supporting the inclusion of learning the skill of changing position. The subtheme, *how I swim with back pain*, supported the value of hybrid strokes and the subtheme, my training regime, included sculling, supporting the inclusion of these skills. The subthemes, *my training regime*, and *my barriers to swimming and how I overcome them*, supported the importance of including aquatic breathing and the	**COM-B Physical and psychological capability** **BCW Intervention function** **Education and training** Learning to change position in water (e.g., from front to back), using the core muscles during these transitions and relaxing the spine to allow it to move freely. Being aware how this feels different in the water when compared to being on dryland. Practicing different ways of turning at end of length, finding out which feels more comfortable. If nerve damage affecting one leg, then look at how could modify push off wall. **COM-B Physical and psychological capability** **BCW Intervention function** **Education and training** Trying hybrid strokes if standard strokes do not agree with them, looking at different combinations of
Code: Hybrid strokes (AP); **COM-B Physical and psychological capability** (Trialling hybrid strokes, this could be considered if issues		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability**		

with other joints such as shoulders and knees) *'Use hybrid strokes to get people moving.'* (P1 SP)		*'Double armed backstroke, old English backstroke. If I am really stiff then I will do that as well, not just normal backstroke. Like when I do my stand up double armed stretch, I can get them back as far as I possibly can. And the weight of your legs sort of almost helps the stretch on your back. So, a big kick ad a massive glide and try and get those back as far as I can. For however many lengths it takes'. (S3 Pool swimmer)*	subtheme*, my feelings about swimming*, supported the inclusion of awareness exercises. There was no data to integrate for the skills of learning to tread water, floating and gliding. The integration of the data supported the inclusion of learning how to cope with a painful episode whilst swimming, entries and exits, changing position in the water, hybrid strokes, sculling, aquatic breathing, awareness exercises, and the data from the round one survey supported the inclusion of learning to tread water, floating and gliding. When mapped onto the COM-B model the core aquatic skills related to the psychological and physical capability dimensions and the intervention functions would be education and training.	arm propulsion, kick, and body positions, which combination feels best for them. This could be considered if issues with other joints, such as shoulders or knees **COM-B Physical and psychological capability** **BCW Intervention function Education and training** Learning to float**,** trying different head, body, arm, and leg positions in water, feeling which ones are more comfortable for their back. Learning to relax while floating in the water. Learning how to stretch whilst floating. Using floating to increase core strength. Using floating to deal with panic in the water or if experiencing cramp. Using equipment to support body whilst floating. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Code: Floating (AP); COM-B Physical and psychological capability (Learning how to float, using floating to deal with panic or cramp and using floating to improve core strength) *'Floating for all swimmers is an essential life skill and engages the core muscles.'* (P7 SP)				
Code: Sculling (AP); COM-B Physical and psychological capability *'I love to float a scull.'* (P14 LBP)		**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity**		

		'I do some sculling, I'll just do a couple of lengths of just travelling stretches so sculling with my arms above my head.' (S12 Pool swimmer)		Developing a feel for the water with hands through sculling, feeling how core muscles are recruited with this movement, trying sculling in different positions (on back, on front and vertical). **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Code: Treading water (IV); COM-B Physical and psychological capability (Learning how to tread water or jog in deep water) *'Treading water, being able to indicate that they need support.'* (P11 SP)				Learning how to tread water and jog in deep water with a float, trying different arm and leg movements, feeling which movements are more comfortable for back. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Code: Aquatic breathing (AP); COM-B Physical and psychological capability (Breathing exercises and awareness of different styles of breathing, being able to put face in the water) *'Initially being able to breathe with head in the water'* (P3 SP)		**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** **Subtheme My barriers to swimming and how I overcome them; COM-B Physical and psychological capability** *'A friend told me I should be breathing every three not every two so that you are not permanently breathing one side, so I am breathing every three but in order to do that I*		Breathing exercises with head out and in the water, mindful breathing, compare breathing out through mouth and nose, compare different speeds

		had to get rid of my legs.' (S1 Outdoor swimmer) *'I have only just started today to learn to how to put my face in the water in the swimming pool that is over a year on.' (S9 Outdoor swimmer)* *'Now I breathe every four, I was just breathing when I needed to breathe and then it was really 'gaspy'. So, Graham said to me that you don't need to hold the breath. As soon as you breathe in just let it go straight away.' (S3 Pool swimmer)* *'I do 3,5,7,9 breathing ladders.' (S12 Pool swimmer)*		of inhalation and exhalation. Develop an awareness of how body feels with different styles of breathing, discover which variation feels more comfortable for back and breathing. Discuss concerns about putting face in water such as feeling claustrophobic. Learning how to fit and wear goggles so able to relax when breathing in water. Learn how breathing exercises can be used to manage anxiety, pain, and focus on the present moment. **COM-B Physical and psychological capability** **BCW Intervention function Education and training** Learning to glide and move in a streamline way, trying different head, body, arm, and leg positions in the water, feeling which ones are more comfortable for back and which improve the efficiency of the movement through the water.
Code: Gliding (AP); COM-B Physical and psychological capability (Learning how to glide in a streamline way) *'Moving in a streamline way.'* (P6 Ph)				
Code: Awareness exercises (IV); COM-B Physical and psychological capability		**Subtheme: My feelings about swimming; COM-B Automatic and reflective motivation**		

(Awareness exercises and learning to be in the present moment) *'Love the sound of relaxation floating & focussing on breath!'* (P9 LBP)		*'I was saying to someone the other day, you know you are literally having to stay alive aren't you and focusing on just that process of staying afloat. I think with my back pain it's always in the back of my mind even if there isn't any, I am pre-empting almost, the more I do it the less I have been kind of worrying about it.' (S10 outdoor swimmer)*		**COM-B Physical and psychological capability** **BCW Intervention function Education and training** Awareness exercise**:** do they feel more confident moving in the water than on land, can they do more in the water, do they have less fear of movement, does their back feel different in the water, do they have less back pain in the water, do their muscles feel more relaxed in the water, do they feel that the water is providing support for their back? Trying different movements that they struggle with on land in the water, if this movement feels easier, practising it in water. Learning to be in the present moment during swim. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**

Swimming strokes				
Study three Round one QUAL	**Study one QUAN**	**Study two QUAL**	**Meta inferences, interpretations, and COM-B and BCW analysis**	**Study three Round two QUAN**
All strokes				
Code: Unsure of stroke (AP); COM-B Physical and psychological capability (Unsure which stroke to swim with LBP) Not mentioned	**Barrier:** 79.7% agreed that they were not sure which stroke was best for LBP; **COM-B Psychological capability**		**Convergence, Divergence and Complimentary** Three a priori codes were used, and twelve in vivo codes were developed to analyse the data from the round one survey to guide the teaching of all the swimming strokes: *unsure of stroke, hybrid strokes, no stroke preference, mixing of strokes, head position, problem solving, breathing streamline swimming, rotation, undulation, arch in back, body alignment, lengthening through spine, language, and nerve damage.* When the data was integrated from study one and two some of the data was congruent, some data was divergent and new insights were observed based	**Suggested components to stroke section** Front crawl, backstroke, and breaststroke to be included in programme. See individual stroke section for teaching points.
Code: Hybrid strokes (AP); COM-B Physical capability		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability**		**Learning alternative ways to swim on the back** such as old English backstroke

(Use of hybrid strokes such as old English backstroke) *'Use hybrid strokes to get people moving.' (P1 SP)* *'Look at Old English backstroke with breaststroke legs, developing a good doggy paddle to safely get to the side or shallow if needed.' (P11 SP)*		*'Double armed backstroke, old English backstroke. If I am really stiff then I will do that as well, not just normal backstroke. Like when I do my stand up double armed stretch, I can get them back as far as I possibly can. And the weight of your legs sort of almost helps the stretch on your back. So, a big kick ad a massive glide and try and get those back as far as I can. For however many lengths it takes'. (S3 Pool swimmer)*	upon the barriers data and the subthemes, *how I swim with back pain, my barriers to swimming and how I overcome them, my training regime, and how my back feels when I swim*. The barriers data from study one found that 79.7% of participants were unsure which stroke was best for LBP, however there was no mention of this uncertainty in study two or in the round one survey. The subtheme, *how I swim with back pain*, was divergent with regards to the suggestion in the round one survey that there was no preference over which stroke could be used, the participants in study two reported having a stroke preference for the back. The subtheme, *how I swim with back pain*, was congruent with the recommendation of hybrid strokes such as old English backstroke, mixing the strokes, being streamline when swimming, adapting for nerve damage and taking a problem-solving approach.	(breaststroke kick and double arm pull) or sculling with breaststroke or flutter kick, being aware how back feels with different versions of stroke. **Learning how to do breaststroke kick on back**, with sculling arms or double arm pull (old English backstroke), feeling how this change in position affects their back, is there less lumbar extension? Use this position on back to improve awareness and develop breaststroke kick. Use noodle if requires support initially.
Code: No stroke preference (IV) (No preference which stroke could be used) *'I have no significant preference, as I think movement is the most important element.' (P6 Ph)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'The whole action of breaststroke I don't think lends itself to back pain either really.' (S13 Outdoor swimmer)*		
Code: Mixing strokes (IV); COM-B Physical capability (Combination of strokes)		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability**		Alternately stroke on front and back, if back better changing position more frequently.

'All strokes are ok in moderation, regularly changing position and stroke would be best approach.' (P4 Ph)		*'So front crawl I would say is the stroke that I would say I favour but I try and do all three as a balance. I normally warm up and do 2 lengths of front crawl and after that I do ½ a length of breaststroke and then go on to the front crawl and then repeat. I then may reach the side, do ½ length backstroke and then go onto front crawl (swimming in large tidal pool).' (S7 Outdoor swimmer)* *'I will do a lot of mixing in the backstroke and the breaststroke with the front crawl. I would much rather not do more than one length of front crawl at a time really if could.' (S3 Pool swimmer)*	The subthemes, *how I swim with back pain* and *my barriers to swimming and how I overcome them*, were congruent for considering the head position when swimming. The subthemes, *how I swim with back pain*, and *how my back feels when I swim*, were congruent with the recommendation of considering rotation, the arch in the low back and the body alignment when swimming. The subthemes, *my training regime*, and *my barriers to swimming and how I overcome them*, was congruent with considering breathing style when swimming. There was no reference to undulation or being careful of language which could promote avoidant behaviour when teaching swimming in study one or two, however it was suggested that these factors should be considered in the round one survey. The subtheme, *how I swim with back pain*, had mentioned finding lengthening through	
Code: Head position (IV); COM-B Physical capability (Considering the head position when swimming) *'Head position - can increase or decrease pressure in the lumbar area, no creased neck.' (P3 SP)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: My barriers to swimming and how I overcome them; COM-B Physical and psychological capability** *'I took lessons to improve my swimming. I have never been*		Learning to swim backstroke with **head looking up**, not down the pool to relax neck muscles and to reduce sinking of legs, being aware how head position changes low back position whilst swimming. Learning to follow ceiling or if outside shore or bank to reduce

		able to front crawl or anything like that so I can do that now, I put my head under the water when I swim. I do it all correctly now. It is an achievement for me at my age.' (S8 Pool swimmer) *'If I am trying to do head up swimming that will strain my back a little bit.' (S11 pool swimmer)* *'You have seen on the videos that I did for Graham, he had noticed a few things, particularly about my breathing, he has changed my head position and I wonder if that has helped with the discomfort, the pain.' (S3 Pool swimmer)*	the spine beneficial, however this was not discussed in the round one survey. When mapped onto the COM-B model the psychological and physical capability dimensions would be needed when considering the teaching of the swimming strokes. The BCW analysis suggested that education and training should be considered for this section of the programme to increase the participant's knowledge and skills about the swimming strokes.	disorientation in this position and to keep swimming course straight. Learning to swim front crawl with **head looking straight down**, not forwards to relax neck and back muscles and not extend lumbar spine
Code: Problem solving (IV); COM-B Physical and psychological capability (Taking a problem-solving approach) *'I think you naturally adjust your own strokes to fit your comfort and ability, that's what I did!' (P9 LBP)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'I have to be selective about which strokes I do, depending on what my pain levels are.' (S12 Pool swimmer)*		**Practising different head positions** during the stroke cycle, allowing the head to dip to relax neck muscles when face in the water, feeling how different positions effect their neck and back.

'Facilitate participants to learn when things don't go to plan, adjust and re-evaluate...core skills in managing chronic pain related to problem solving.' (P8 Ph)				Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back (**a problem-solving approach**)
Code: Breathing (IV); Physical capability (Breathing style when swimming) *'Making sure the head goes under with breaststroke, breathing on left and right sides with freestyle.' (P4 Ph)*		**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** **Subtheme My barriers to swimming and how I overcome them; COM-B Physical and psychological capability** *'A friend told me I should be breathing every three not every two so that you are not permanently breathing one side, so I am breathing every three but in order to do that I had to get rid of my legs.' (S1 Outdoor swimmer)* *'I have only just started today to learn to how to put my face in the water in the swimming pool that is over a*		**Being mindful to exhale** in the water and to inhale the normal amount of air, not hyperventilate. Practising different intervals when taking a breath. Compare breathing through mouth and nose. Practise different speeds of inhalation and exhalation. Compare different head positions when taking breath to the side. Discover which variation feels more comfortable for back and for breathing.

		year on.' (S9 Outdoor swimmer) *'Now I breathe every four, I was just breathing when I needed to breathe and then it was really 'gaspy'. So, Graham said to me that you don't need to hold the breath. As soon as you breathe in just let it go straight away.' (S3 Pool swimmer)* *'I do 3,5,7,9 breathing ladders.' (S12 Pool swimmer)*		
Code: Streamline swimming (IV); COM-B Physical capability (Importance of adopting a streamline position in the water) *'Increased streamline positions seem to cause less pain in my experience. Including additional breaks and using kickboards and pull buoys seems to be beneficial.' (P10 SP)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'So, I just tend to be streamline, hand over hand, either on my back or on my front.' (S2 Pool swimmer)*		Learning how to adopt a more **streamline position** in the water for their body so that less effort required to swim, adding a pull buoy or flotation trunks if required so swimming close to surface.
Code: Rotation (IV); COM-B Physical capability		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability**		**Improving rotation** of the trunk so that the whole body rotates, learning to

(Reference to rotation when swimming) *'Front crawl and backstroke. They both generally maintain an elongated and stretched position but with a gentle twist.' (P14 LBP)* *'Maybe back stroke if it is learnt slowly and avoids twisting.' (P11 SP)*		**Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'Front crawl also helped with the stiffness in my back because of the rotation action required.' (S4 Pool and outdoor swimmer)* *'I glide better with that side than that side and you don't twist.' (S6 Pool and outdoor swimmer)*		breathe both sides if possible. Learning to move smoothly through water using this rotation. Drills to enhance rotation could include 6 kicks and roll and a single-arm drill. Do they feel better using front crawl to improve the rotation in spine or is it more comfortable to rotate the whole body? **Learning how to improve rotation** of body during backstroke. Being aware how this could increase the feeling of lengthening in spine and improve the efficiency of the arm pull. Do they feel better using back stroke to improve the rotation in the spine or is it more comfortable to rotate the whole body? Using this rotation to move smoothly through water. Drills: single arm pull, not over kicking, kick only to keep legs in correct position in water
Code: Undulation (IV); Physical capability				Trying breaststroke with **more and less undulation**. Do they feel

(Reference to undulation when swimming) *'Non body undulating stokes. Freestyle and backstroke. No body undulation.' (P2 SP)*				better using more undulation to mobilise the lumbar spine or less undulation?
Code: Arch in back (IV); COM-B Physical capability (Reference to arch in back or extension in low back when swimming) *'Backstroke and front crawl as they are performed more horizontally whereas butterfly and breaststroke can cause a natural arch in the lower back.' (P16 SP)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'I do breaststroke in the sea when it is rougher, but that doesn't work as well because I end on coming up more, so if anything, my back, my pelvis, I don't know, I have a bit too much curve in the bottom of my back.' (S1 Outdoor swimmer)* *'I certainly can't do more than probably about 4 lengths of breaststroke because again, it is the position, it does slightly extend my back.' (S14 Pool swimmer)*		Learning to swim backstroke with **body on the surface of the water** and a slight angle downwards with legs, but not allowing legs to sink too much so less extension in lower back. Feeling that movement through water in this position is more streamline and less effort is required. Drills include kicking with the noodle underarms, kicking on back hugging float, using small pull buoy, wearing floatation trunks. **Learning flatter breaststroke** with slower stroke turnover (less ballistic), longer glide and wedge kick (the older style of swimming breaststroke). Being aware of the feeling of lengthening through spine during glide phase.

		'Butterfly obviously is quite a big arch on my back.' (S12 Pool swimmer)		
Code: Body alignment (IV); COM-B Physical capability (Reference to body alignment when swimming) *'Whichever stroke is used correct alignment is key as otherwise pressure is placed on the neck which causes many problems.' (P13 LBP)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'But with front crawl my perception is that I am flatter in the water and that's what I tried to do.' (S1 Outdoor swimmer)*		**Practising different head positions** during the stroke cycle, allowing the head to dip to relax neck muscles when face in the water, feeling how different positions effect their neck and back. Learning to swim front crawl with lower **body position** in the water, at an angle rather than in line with the water surface; lifting the back and dropping the legs in the water so that lumbar spine is in less extension / neutral position. Optional use of equipment such as noodles under trunk to support swimmer in this position.
Code: Lengthening through spine (AP) Not mentioned		**Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'To stretch my back out and try and lengthen my back*		Increasing the feeling of **lengthening** in the spine whilst swimming with stronger pull and not 'over kicking'. The following drills could be used; arms only with pull buoy, catchup,

		because my job has become more desk based.' (S1 Outdoor swimmer)		focusing on extending the arm in front before the next stroke, trying different kick beats (6,4,2) and feeling difference with back. **Learning flatter breaststroke** with slower stroke turnover (less ballistic), longer glide and wedge kick (the older style of swimming breaststroke). Being aware of the feeling of lengthening through spine during glide phase. **Experiencing swimming breaststroke under the water** for example trying the drill; 3 kicks above water, 3 kicks below the water or breaststroke legs only under water. Being aware of feeling of weightlessness under underwater and lengthening of spine.
Code: Language (IV); COM-B Psychological capability (Reference to language when teaching swimming strokes)				

'Very careful to "avoid" language that could reinforce fear avoidant behaviours (e.g., telling people not to turn their necks or to adjust their posture when not relevant to stroke techniques).' (P8 Ph)				
Code: Nerve damage (IV); COM-B Physical capability (Reference to changes due to nerve damage) *'I've got a foot drop so for all strokes my concern would be my legs. I'd want a pull buoy with a loose ankle strap to start with.' (P14 LBP)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'The worst thing with indoor swimming is turning, so obviously pushing off the side when things aren't working very well. My body is a lot stronger now; I think I have got about 80% nerve use of this leg.' (S6 Pool and outdoor swimmer)*		Recognised in all parts of programme If unable to use legs whilst swimming (e.g., due to nerve damage) finding ways to swim and keep in a streamline position either with floats, using core or increasing speed. If nerve damage only affecting one leg, find out whether better for back to use just one leg or no legs.
Front crawl				
Code: Front crawl best stroke (AP); COM-B Physical capability and Automatic motivation (Front crawl considered one of the best strokes for someone with LBP) *'Front crawl is far more comfortable for me, but it*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'So, I tend to concentrate on front crawl, that's the one I*	**Convergence** Four a priori codes were used to analyse the data from the round one survey to guide the teaching of front crawl: *front crawl best stroke, adapting front crawl, avoidance, or caution with front crawl, ands front crawl drills*. When the data was	**The following teaching points for front crawl were suggested in the round two survey** Learning to swim front crawl with **head looking straight down**, not forwards to relax neck and

might depend on a person's pain!' (P9 LBP)		*feel most comfortable with' (S2 Pool swimmer)* *'I am more comfortable using front crawl and back crawl.' (S12 Pool swimmer)*	integrated with study two, the subthemes, *how I swim with back pain* and *how my back feels when I swim*, were congruent with the suggestion that front crawl was the best stroke for people with LBP, that for some people the stroke could be adapted to lessen discomfort, for some people there was the need for caution with the stroke but not avoidance and that swimming drills or exercises could be used alongside this stroke. The integration of the data supported the inclusion of breathing exercises, problem solving, learning to adapt swimming for nerve damage, learning to become more streamline, learning to improve rotation, considering the head position, increasing the feeling of length through the spine, and learning to swim with a low body position in the water.	back muscles and not extend lumbar spine Learning to swim front crawl with lower **body position** in the water, at an angle rather than in line with the water surface; lifting the back and dropping the legs in the water so that lumbar spine is in less extension / neutral position. Optional use of equipment such as noodles under trunk to support swimmer in this position. Learning how to adopt a more **streamline position** in the water for their body so that less effort required to swim, adding a pull buoy or flotation trunks if required so swimming close to surface. **Improving rotation** of the trunk so that the whole body rotates, learning to breathe both sides if possible. Learning to move smoothly through water
Code: Adapting front crawl (AP); COM-B Physical capability (Changes which could be made to someone when swimming front crawl) *'In free style a relaxed body position e.g., lower in the water at an angle rather than in line with water surface.' (P2 SP)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'So, for my back the one that I am consciously trying to do is front crawl but only using my arms, which I do not know whether it is right or wrong but it means that I am just lengthening in the water all the time.' (S1 Outdoor swimmer)* *The actual freestyle stroke, I wouldn't have thought I would have had to modify it at all because I can keep straight and pivot, I don't think I have made any concessions at all. (S4 Pool and outdoor swimmer)*		

		'I changing a little bit of my stroke, trying different things; but it doesn't affect my back whatsoever.' (S5 Pool and outdoor swimmer) *'I will almost lift my lower back and drop my legs because after a while if I do get in the same position for too long and relaxed, I do tend to arch and that, it doesn't necessarily cause pain, but it is just uncomfortable.' (S14 pool swimmer)*		using this rotation. Drills to enhance rotation could include 6 kicks and roll and a single-arm drill. Do they feel better using front crawl to improve the rotation in spine or is it more comfortable to rotate the whole body? **Being mindful to exhale** in the water and to inhale the normal amount of air, not hyperventilate. Practising different intervals when taking a breath. Compare breathing through mouth and nose. Practise different speeds of inhalation and exhalation. Compare different head positions when taking breath to the side. Discover which variation feels more comfortable for back and for breathing. Increasing the feeling of **lengthening** in the spine whilst swimming with stronger pull and not 'over kicking'. The following drills
Code: Avoidance or caution with front crawl (AP); COM-B Physical capability *'? crawl.' (P15 Ph)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'With the initial injury it (front crawl) actually made it a bit worse. I found that the position that I was in in the water when swimming on my front wasn't good '(S14 Pool swimmer)*		

Code: Front crawl drills (AP); COM-B Physical capability (Front crawl exercises and drills) *'I enjoy freestyle kicking on my back hugging a float as I feel is opens my back up.' (P12 LBP)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'So, catch up drills and ripple, where you run your fingers across the water. Yes, anything freestyle wise I have found good. The good thing about the catchup drills is you are stretching forwards, you are stretching; I have found that helps loosen up the back because you are stretching the sides, potentially. When you are in pain you tend to tighten everything up, you hold everything in a little bit, so that kind of drill helps loosen everything up a bit'. (S2 Pool swimmer)* *'Anything that ultimately stretches out the back so I would say something like catch up drill, kicking drills.' (S4 Pool and outdoor swimmer)* *'I am conscious that I am extending my arms before the next stroke.' (S7 Outdoor swimmer)*		could be used; arms only with pull buoy, catchup, focusing on extending the arm in front before the next stroke, trying different kick beats (6,4,2) and feeling difference with back. If unable to use legs whilst swimming (e.g. due to nerve damage) finding ways to swim and keep in a streamline position either with floats, using core or increasing speed. If nerve damage only affecting one leg, find out whether better for back to use just one leg or no legs. Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back (**a problem-solving approach**) **COM-B Physical and psychological capability** **BCW Intervention function** **Education and training**

		'I have swim fins.' (S7 Outdoor swimmer) *'I found pull buoys, because they tend to force your legs up, they tend to arch your back so I find, although I do use them, I can't use them for any length of time, because then it is putting pressure on that point on the back where it is making it uncomfortable.' (S2 Pool swimmer)* *'6 to 1 and change, when you do 6 kicks with the fins and one stroke with the hand and then changing the body rotation and doing exactly the same. That is quite smooth. When I have a pull buoy in front, on the top of my hands, with straight hands and just kicking that helps as well with the body flat on the water.' (S5 Pool and outdoor swimmer)* *'I might also do catch up if it is particularly uncomfortable, because I can properly, you*		

		have extra time to stretch properly.' (S3 Pool swimmer)		
Backstroke				
Code: Backstroke best stroke (AP); COM-B Physical capability and Automatic motivation (Backstroke considered one of the best strokes for someone with LBP) *'Front crawl and backstroke. They both generally maintain an elongated and stretched position but with a gentle twist.' (P14 LBP)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'I probably find backstroke the most relaxing, the least amount of pressure on my back'. (S11 Pool swimmer)* *'Backstroke is good JB* *The backstroke is the most helpful stroke.' (S3 Pool swimmer)* *'With the initial injury it actually made it a bit worse. I found that the position that I was in in the water when swimming on my front wasn't good. The only way that I could swim comfortably was on my back.' (S14 Pool swimmer)*	**Convergence and Divergence** Four a priori codes were used to analyse the data from the round one survey to guide the teaching of backstroke: backstroke best stroke, adapting backstroke, avoidance, or caution with backstroke, and backstroke drills. When the data was integrated from study new insights were observed based upon the subthemes, *how I swim with back pain, how my back feels when I swim, my barriers and how I overcome them*. When the data was integrated with study two, the subthemes, *how I swim with back pain* and *how my back feels when I swim*, were congruent with the suggestion that backstroke was the best stroke for people with LBP and that there was no need to adapt the stroke to lessen discomfort. There was no	**The following teaching points for backstroke were suggested in the round two survey** Learning to swim backstroke with **head looking up**, not down the pool to relax neck muscles and to reduce sinking of legs, being aware how head position changes low back position whilst swimming. Learning to follow ceiling or if outside shore or bank to reduce disorientation in this position and to keep swimming course straight. Learning to swim backstroke with **body on the surface of the water** and a slight angle downwards with legs, but not allowing legs to sink too much so less extension in lower back. Feeling that movement through water
Code: Adapting backstroke		**Subtheme: My barriers and how I overcome them; COM-**		

(Changes which could be made to someone when swimming backstroke) No reference to changing backstroke		**B Physical and psychological capability** *If anything, I have improved, rather than steer away, the backstroke is just a confidence thing, but I could do it.' (S8 Pool swimmer)*	mention of avoidance or caution with backstroke in the round one survey, however the subthemes, *how I swim with back pain* and *how my back feels when I swim*, were divergent in that there was the suggestion of caution swimming backstroke outdoors because of sighting difficulties and some people may struggle to keep the centre of the body up when swimming this stroke which could cause discomfort. The data from the round one survey suggested swimming drills or exercises could be used alongside this stroke, there was no data in study two for meta inference for this section. The integration of the data supported the inclusion of problem solving, breathing exercises, learning other forms of backstroke, considering head position, learning to use the flags, learning to improve rotation, and learning to swim with the body on the surface of the water.	in this position is more streamline and less effort is required. Drills include kicking with the noodle underarms, kicking on back hugging float, using small pull buoy, wearing floatation trunks. **Learning how to improve rotation** of body during backstroke. Being aware how this could increase the feeling of lengthening in spine and improve the efficiency of the arm pull. Do they feel better using back stroke to improve the rotation in the spine or is it more comfortable to rotate the whole body? Using this rotation to move smoothly through water. Drills: single arm pull, not over kicking, kick only to keep legs in correct position in water **Being mindful to exhale** through nose so water does not enter nose whilst on back and to inhale the normal amount of air,
Code: Avoidance or caution with backstroke (AP); COM-B Physical capability No reference to avoiding backstroke		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'I only tried backstroke in June when I started swimming in the sea and I didn't get on with it, and I don't know why…I actually found it quite hard work on my arms I might be able to try it again, I also found that I got dizzy quicker, it was more disorientating because you have nothing to fix on' (S1 Outdoor swimmer)* *'I'm aware that there is more pressure on my lower spine when I kick, presumably because that's me trying to*		

		keep my centre up. (S7 Outdoor swimmer)		not hyperventilate. Practising different
Code: Backstroke drills (AP); COM-B Physical capability (Backstroke exercises and drills) *'Backstroke could be gentle leg kick using a noodle under arms so working legs and back but with little jerky body movement.' (P2 SP)*				intervals when taking breath with stroke. Practise different speeds of inhalation and exhalation. Discover which variation feels more comfortable for back and for breathing. **Learning how to use the flags** when swimming backstroke so able to judge how close to the end and therefore allowing the swimmer to stay on their back and relax when swimming this stroke. **Learning alternative ways to swim on the back** such as old English backstroke (breaststroke kick and double arm pull) or sculling with breaststroke or flutter kick, being aware how back feels with different versions of stroke. Trialling different head, body, and leg positions for each

				swimmer, learning how to make the stroke more comfortable for their back (**a problem-solving approach**) **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Breaststroke				
Code: Breaststroke best stroke (AP); COM-B Physical capability and Automatic motivation (Breaststroke considered one of the best strokes for someone with LBP) *'It varies. I tend to do more breaststroke as this means I'm using my legs. My legs are very weak, and I find the action of front crawl kick requires concentration and can't be sustained. Whichever stroke is used correct alignment is key as otherwise pressure is placed on the neck which causes many problems.' (P13 LBP)*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'Breaststroke, Front crawl, that doesn't affect me but with breaststroke you have to be careful with your knee. Breaststroke is my strongest one. Front crawl I focus more on the breathing, it is the difficult one to coincide everything. Breaststroke is my main strength.' (S8 Pool swimmer)*	**Convergence and Complimentary** Four a priori codes were used to analyse the data from the round one survey to guide the teaching of breaststroke: breaststroke best stroke, adapting breaststroke, avoidance, or caution with breaststroke, and breaststroke drills. When the data was integrated with subthemes, *my barriers and how I overcome them* and *how my back feels when I swim*, new insight were observed including avoidance of the stroke based upon recommendations from health professionals, discomfort with the stroke due to knee problems,	**The following teaching points for breaststroke were suggested in the round two survey** **Learning flatter breaststroke** with slower stroke turnover (less ballistic), longer glide and wedge kick (the older style of swimming breaststroke). Being aware of the feeling of lengthening through spine during glide phase. **Practising different head positions** during the stroke cycle, allowing the head to dip to relax neck muscles when face in the water, feeling how different positions effect their neck and back.
Code: Adapting breaststroke (AP); COM-B Physical capability		**Subtheme: My barriers and how I overcome them; COM-**		

(Changes which could be made to someone when swimming breaststroke) *'Making sure the head goes under with breaststroke' (P4 Ph)*		**B Physical and psychological capability** *'I had a couple of lessons with a teacher, near Bodium in the river, and she was teaching me a better breaststroke. So really going down into the water and up and she was saying if you are swimming above the water the whole time it is really bad for you, it will strain your back so yes, I would say that I am quite careful about really following, I have her words in my mind that I really focus on my stroke.' (S10 Outdoor swimmer)*	avoiding the stroke during a flare up or early during the session, and discomfort due to the position of the low back during the stroke. The data from the subtheme, *how I swim with back pain*, was congruent for the drills and exercises to lessen discomfort during breaststroke suggested for this stroke in the round one survey. The integration of the data supported the inclusion of breathing exercises, problem solving, considering the head position, trying different ratios of kick to pull, practising kick on the back, trying a stroke with more or less undulation, experiencing swimming underwater and learning a flatter stroke.	Trying breaststroke with **more and less undulation**. Do they feel better using more undulation to mobilise the lumbar spine or less undulation? **Being mindful to exhale** in the water and to inhale the normal amount of air, not hyperventilate. Practising different lengths of glide, which will affect intervals when taking a breath and different speeds with stroke transitions (e.g., from pull to glide). Compare breathing through mouth and nose. Practise different speeds of inhalation and exhalation. Discover which variation feels more comfortable for back and for breathing. **Trying different ratios of kick and pull**, e.g., two kicks to one pull so longer period when flatter in water, feel
Code: Avoidance or caution with breaststroke (AP); COM-B Physical capability *'Head up breaststroke.' (P1 SP)*		**Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'But I was told never to do breaststroke and I have never ever been able to do*		

		breaststroke.' (S6 Pool and outdoor swimmer) *'Although I have subsequently found out that your knees get grumpy if you do too much breaststroke.' (S1 Outdoor swimmer)* *'I am conscious with the breaststroke it causes some compression of my lower spine, and I am wary.' (S7 Outdoor swimmer)* *'If I do a lot of breaststroke, I find it pulls on the bottom of my back.'(S2 Pool swimmer)* *'I had a flare up recently so basically that meant when I was doing breaststroke it was quite painful but not painful, uncomfortable. So, I basically cut out breaststroke from that swim set.' (S11 Pool swimmer)* *'It tends to take me quite a long time, maybe 800m before I feel like I can do a breaststroke. Because I have got the bit of your back arch*		the difference with different ratios on back. **Learning how to do breaststroke kick on back**, with sculling arms or double arm pull (old English backstroke), feeling how this change in position affects their back, is there less lumbar extension? Use this position on back to improve awareness and develop breaststroke kick. Use noodle if requires support initially. Alternately stroke on front and back, if back better changing position more frequently. **Experiencing swimming breaststroke under the water** for example trying the drill; 3 kicks above water, 3 kicks below the water or breaststroke legs only under water. Being aware of feeling of weightlessness under underwater and lengthening of spine.

		going and the dodgy knees, but mainly my back doesn't feel like it wants to go that way.' (S3 Pool swimmer) *'I tend to avoid doing the breaststroke sets until almost the end of the session.' (S12 pool swimmer)*		Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back (**a problem-solving approach**)
Code: Breaststroke drills (AP); COM-B Physical capability (Breaststroke exercises and drills) *'If the participant really needed to swim breaststroke it could be recommended that they practice putting their face in when gliding to take pressure away from the neck and back. That they try to swim as flat as possible and ensure their kick was correct. If the head is held up for long periods it can put pressure on the lower back as it causes a bend through the spine, then coupled with the frog type kick it will cause further problems for the hips and knees, particularly if done incorrectly. The*		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'So, breaststroke leg kick, I find I like the leg kick and as long as I keep myself in a horizontal position. So, there is a drill we do, 3 kicks up on the water and 3 kicks under the water and that's a nice drill for me, you dive down and because you are not trying to keep your head above the water, you can keep yourself in a more horizontal plane and therefore that helps. And it is just nice; I am liking the breaststroke leg kick for the symmetry and the feel of the power. I just enjoy that drill.' (S2 Pool swimmer)*		**COM-B Physical and psychological capability** **BCW Intervention function Education and training**

participant could practice old English on their back or even side stroke if they tried both sides to ensure equal strengthening.' (P7 SP)		*'When my legs frog, instead of putting them together and toes together, not just doing one side. So, I really get that part. Bringing them back together and then you get further if you see what I mean so that's always in my mind, what she taught me.' (S8 Pool swimmer)*		
Butterfly				
Code: Butterfly best stroke (AP); COM-B Physical capability and Automatic motivation (Butterfly considered one of the best strokes for someone with LBP) No reference to butterfly being the best stroke		No reference to butterfly being the best stroke	**Convergent and Complimentary** Four a priori codes were used to analyse the data from the round one survey to guide the teaching of butterfly: '*butterfly best stroke', 'adapting butterfly', 'avoidance, or caution with butterfly', and 'butterfly drills*.' There was no data in the round one survey to suggest that butterfly would be the best stroke for someone with LBP. When the data was integrated with subthemes, *my barriers to swimming and how I overcome them*, it was noted that there were some	It was decided that butterfly would not be included in the swimming programme.
Code: Adapting butterfly (AP); COM-B Physical capability (Changes which could be made to someone when swimming butterfly) No reference to adapting butterfly		**Subtheme: My barriers to swimming and how I overcome them; COM-B Psychological and physical capability** *'If it's fly, I just can't do fly then I will do one arm, just adapting the stroke.' (S3 Pool swimmer)*		

Code: Avoidance or caution with Butterfly (AP); COM-B Physical capability *'Initially avoid butterfly but would look at introducing and checking no significant aggravation.' (P4 Ph)* *'Butterfly. There's so much movement in the back and this one causes me the most pain and tightness in my lower back unless I only do fly kicks with a float.' (P12 LBP)* *'Butterfly has not been suitable.' (P10 SP)*		**Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'But my back wouldn't be flexible enough to take the fly, so I have learned to leave that.' (S4 Pool and outdoor swimmer)* *'Butterfly, I have never ever been able to do that, I have never really wanted to, to be honest'. (S8 Pool swimmer)* *'When you are doing full fly, I find it does pull, but it is kind of belligerence that drives you through those things, rather than sensibility, you kind of want to do them because you want to do them.' (S2 Pool swimmer)* *'But not fly; it can cause pain.' (S5 Pool and outdoor swimmer)* *'It takes me ages to get going on fly, it is obviously extreme movement. That's not just to do with my back that's my*	adaptations to butterfly which could make the stroke more suitable for some people with LBP. When the data was integrate with the subtheme, *how my back feels when I swim*, the data was congruent for avoiding or being cautious with swimming butterfly. The participants in the round one survey did not suggest butterfly drills or exercises, however, the subtheme, *how I swim with back pain*, had identified that butterfly kicking in supine could be helpful for some people with LBP. Based upon the data it was decided that butterfly would not be included in the swimming programme.	

		shoulders as well.' (S3 Pool swimmer)		
Code: Butterfly drills (AP); COM-B Physical capability (Butterfly exercises and drills) No butterfly drills		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'And I even find butterfly kicking on my back quite good.' (S2 Pool swimmer)*		

Strategies to enable people with CLBP to become regular swimmers				
Study three Round one QUAL	**Study one QUAN**	**Study two QUAL**	**Meta inferences, interpretations, and COM-B and BCW analysis**	**Study three Round two QUAN**
Code: Fun session (IV); COM-B Social opportunity (making session fun, enjoyable and sociable) *'Enjoyment of the session and confidence.' (P16 SP)* *'A positive social experience and fun.' (P13 LBP)*	**Barrier:** 32.1% agreed that they don't enjoy swimming; **COM-B Automatic motivation**	**Subtheme: My swimming community; COM-B Social opportunity** **Subtheme: My feelings about swimming; COM-B Automatic and reflective motivation** *'I enjoy it and I know I am going to get, there is a benefit from it.' (S2 Pool swimmer)* *'We just here for fun, we just do this for fun!' (S9 Outdoor swimmer)*	Convergent, Divergent and Complimentary Three a priori codes were used, and eleven in vivo codes were developed to analyse the data from the round one survey to guide the content of the keeping going with swimming strategies section: *fun sessions, discount, pool information, peer support, reflection, session with family and friends, goal setting and action plans,*	**The following keeping going with swimming strategies were suggested in the round two survey** Making the swimming sessions fun, enjoyable and sociable. **COM-B Social opportunity** **BCW Intervention function Enablement** Subsidised / discounted access to pool

		'I have really enjoyed swimming with others and the group that we have formed now is just such a lovely combination of people, it is really nice to sit and chat afterwards.' (S10 Outdoor swimmer)	*feedback, signposting to specific sessions, drop-in sessions, integration, prompts, and signing up to challenges*. When the data was integrated from study one and two some of the data converged, some data was divergent and new insights were observed based upon the data from study one and the subthemes, *my swimming community, my feelings about swimming, swimming improves my physical and mental health and functional benefits gained through swimming, my goals and motivation, and developing a swimming habit*. The barriers data whereby 32.1% of participants agreed that they didn't enjoy swimming and the subthemes, *my swimming community,* and *my feelings about swimming*, supporting the inclusion of fun and enjoyable swimming. 37.8% of participants in study one agreed that the cost of	**COM-B Physical opportunity** **BCW Intervention function Enablement** Information about access to local pools and cost. Information about changing facilities. Discuss about taking time to prepare to get in the water and to leave the venue. Information about outdoor swimming sessions with further information about safety. **COM-B; Psychological capability** **BCW Intervention function Enablement and education** Developing a peer support group with others in the class, using social media such as WhatsApp or Facebook. **COM-B Social opportunity** **BCW Intervention function Enablement and modelling** Time to reflect on other benefits of swimming, beyond their back pain,
Code: Discount (IV); COM-B Physical opportunity (Subsidised or discounted access to a pool) *'Subsidised access to a pool.' (P6 Ph)* *'Discounted entry to local facilities.' (P4 Ph)*	**Barrier:** 37.8% agreed that the cost of swimming would prevent them from swimming; **COM-B Physical opportunity**			
Code: Pool information (IV); COM-B; Psychological capability (Providing information about local pool) *'Resources of available pools.' (P12 LBP)*	**Preferences** The most popular time was in the morning (9-12pm), 34.2% of participants selected this option, the second most popular time was early evening (5-7pm) with 21.1% choosing this time. 91.0% of participants said that they would prefer to attend an adult only session. 42.0% of female participants and 8.0% of male participants said they would prefer to attend a			

	swimming session with just female or just male swimmers. 39.0% of female participants said they would prefer a session where you were allowed to wear a t-shirt compared to 21.4% of male participants.		swimming would prevent them from swimming, supporting the provision of discounted sessions. The data from study one identified common swimming preferences in this population, supporting the provision of resources about local pools. The subtheme, my swimming community, supported provision of swimming in a group, encouraging peer support, however, in contrast the enablers data from study one identified that only 13.5% of participants agree that they would like to make new friends through swimming. The subtheme, swimming improves my physical and mental health and functional benefits gained through swimming supported the need for time to reflect on the benefits of swimming, beyond back pain. The subtheme, my swimming community, also supported the need for positive feedback from the person	such as improvements in fitness, general health, wellbeing, mood, general muscle strength and flexibility, and being better able to manage a healthy weight. Use these benefits as an additional motivational tool. **COM-B Reflective motivation** **BCW Intervention function Education and persuasion** Encouragement and positive feedback from person leading the class, highlighting improvements since swimming. Time to reflect on benefits for back pain and general health. **COM-B Reflective motivation** **BCW Intervention function Education and persuasion** Signposting to sessions for only adults and for just women or just men. **COM-B Social opportunity** **BCW Intervention function Education and enablement**
Code: Peer support (IV); COM-B Social opportunity (Peer support such as using social media e.g., WhatsApp) *'Peer support to connect and motivate.' (P8 Ph)* *'Group exercise dynamic, perhaps a WhatsApp/Facebook group so that participants can communicate with each other should they wish.' (P10 SP)*	**Enabler:** 13.5% agreed that they would like to make new friends through swimming; **COM-B Social opportunity**	**Subtheme: My swimming community; COM-B Social opportunity** *'With regards to swimming, I really do feel that this group is such a life changing part for me.' (S9 Outdoor swimmer)* *'I thought I was happier swimming on my own just because it is easiest to do, jump in and nip down, no planning. But I have really enjoyed swimming with others and the group that we have formed now is just such a lovely combination of people, it is really nice to sit and chat afterwards.' (S10 Outdoor swimmer)*		
Code: Reflection (IV); COM-B Reflective motivation (Reflection of benefits of swimming beyond back pain)		**Subtheme: Swimming improves my physical and mental health and functional benefits gained through swimming; COM-B**		

'Working on the assumption that the class has benefited their back pain, the benefits to long term health.' (P3 SP)		**Automatic and reflective motivation** *'Keeping the weight off but also keeping my mobility in my back because I know I do seize up if I don't go.' (S3 Pool swimmer)* *'At the moment, it is a bit of a constant cycle for me with weight, but I have set myself some monthly targets and goals.' (S14 Pool swimmer)* *'I know for a fact that I will just put on weight and get really lazy if I don't.'* *(S12 Pool swimmer)*	leading the sessions. None of the participants in round one mentioned specific sessions for men or women or adults, in contrast this was a strong preference in the survey in study one, whereby 91.0% of participants said that they would prefer to attend an adult only session. 42.0% of female participants and 8.0% of male participants said they would prefer to attend a swimming session with just female or just male swimmers and the subtheme, my swimming community mentioned adult only sessions. Furthermore, the participants in round one did not mention providing a session with friends and family, in contrast, the enablers data had identified that 71.1% agreed that they enjoyed swimming with friends / family, and this would encourage them to swim and 66.7% of participants already take their children, a relative or friend swimming. The subtheme, my swimming	Offering a session whereby a partner, family member or friend can join them in the water **COM-B Social opportunity** **BCW Intervention function Enablement** Setting goals, being comfortable prioritising self so able to swim regularly and making a written action plan before the last session. **COM-B Reflective motivation** **BCW Intervention function Education, training, and enablement** Further drop-in sessions at pool **COM-B Physical opportunity** **BCW Intervention function Enablement, training, and environmental restructuring** Integration with regular classes in local pool **COM-B Physical opportunity**
Code: Feedback (IV); COM-B Reflective motivation (Encouragement and positive feedback from instructor) *'Encouragement.' (P5 Ph)*		**Subtheme: My swimming community; COM-B Social opportunity** *'Motivation, if it wasn't for that person or it wasn't for that person to say, 'come on, you can do it, if I can do it, I know that you can do it', then we wouldn't have done it!' (S9 Outdoor swimmer)*		
Code: Signpost sessions for adult only / men only / women only (AP)	**Preferences** 91.0% of participants said that they would prefer to	**Subtheme: My swimming community; COM-B Social opportunity**		

Not mentioned	attend an adult only session. 42.0% of female participants and 8.0% of male participants said they would prefer to attend a swimming session with just female or just male swimmers.	*'Wednesday at Masters.' (S3 Pool swimmer)*	community, also included discussion of swimming with a family member. 76.7% agreed that they lacked motivation to go swimming and 82.0% agreed that setting goals and making an action plan could help them go swimming more regularly and the subtheme, my goals and motivation all supported the use of goal setting and action plans and further drop-in sessions. The subtheme, my swimming habit suggested a regular swimming session could enable swimming, supporting the integration of the programme with local structured sessions. 76.7% agreed that they lacked motivation to go swimming, supporting the suggestion of prompts such as a text to book a swim. There was no data in study one to support the provision of paperwork to support learning after the programme. No one in round one mentioned signing up for challenges, in contrast the subtheme, my goals and	**BCW Intervention function Enablement, training, and environmental restructuring** Email or text prompts to remind them to book a swim session.
Code: Session with family / friend (AP) Not mentioned	**Enabler:** 71.1% agreed that they enjoyed swimming with friends / family, and this would encourage them to swim; **COM-B Automatic motivation and social opportunity** 66.7% of participants already take their children, a relative or friend swimming	**Subtheme: My swimming community; COM-B Social opportunity** *'I take my daughter swimming at the weekend.' (S3 Pool swimmer)*		**COM-B Social opportunity** **BCW Intervention function Enablement** Paperwork to support what they have learned during the class **COM-B Psychological capability** **BCW Intervention function Education and training**
Code: Goals and action plan (IV); COM-B Reflective motivation (Setting goals and making an action plan) *'A plan and or a partner who they have trained with to join up and swim together.' (P2 SP)*	**Barrier:** 76.7% agreed that they lacked motivation to go swimming; **COM-B Reflective motivation** Enabler: 82.0% agreed that setting goals and making an action plan could help them go swimming more regularly; **COM-B Reflective motivation and physical opportunity**	**Subtheme: My goals and motivation; COM-B Reflective and automatic motivation** *'My aim, I can only do a length in 35 seconds, but I want to be quicker.' (S8 Pool swimmer)*		Signing up for a challenge or an event to work towards for example the Swimathon challenge. If not entered an event before, discussing what to expect, so able to enter 'that world', if not from a sporty background. Monitoring swims with an App such as Strava. **COM-B Reflective motivation**

Code: Drop-in sessions (IV); COM-B Physical opportunity (Further drop-in sessions at pool) *'Ongoing drop in facility led by a physiotherapist' (P6 Ph)* *'Continued drop-in group that's paid.' (P4 Ph)*	**Barrier:** 76.7% agreed that they lacked motivation to go swimming; **COM-B Reflective motivation**		motivation suggested that this might be a useful tool to enable swimming. The integration of the data supported the inclusion of making swimming fun, enjoyable and sociable, offering discounted swimming, providing information about access to local pools, developing a peer support group, reflecting on the benefits of swimming, providing encouragement and positive feedback, signposting to sessions for only adults or men or women, providing a session for a family member or friend, setting goals and making an action plan, providing further drop-in sessions, integrating with a local class, sending emails or text reminders, providing paperwork to support learning and signing up for challenges. When mapped onto the COM-B model the keeping going with swimming strategies related to the	**BCW Intervention function Incentivisation**
Code: Integration (IV); COM-B Physical opportunity (Integration with regular class at local pool) *'Any available classes they can attend after.' (P12 LBP)* *'Integration with classes into local pools' (P4 Ph)*		**Subtheme: Developing a swimming habit; COM-B Reflective and automatic motivation** *'Once a week at the moment with masters.' (S12 Pool swimmer)*		
Code: Prompts (IV); COM-B Social opportunity (Email or text prompts to book a swim) *'Prompting to remind them of their next session, email or equivalent.' (P10 SP)*	**Barrier:** 76.7% agreed that they lacked motivation to go swimming; **COM-B Reflective motivation**			
Code: Paperwork (IV); COM-B Psychological capability (Paperwork to support learning)				

'Paperwork with visuals of what they have done and step by step how to do it.' (P12 LBP)			social and physical opportunity, psychological capability, and reflective motivation dimensions and the intervention functions would be enablement, education, training, persuasion, environmental restructuring, incentivisation and modelling.	
Code: Signing up for challenges (AP) Not mentioned		**Subtheme: My goals and motivation; COM-B Reflective and automatic motivation** *'My goal was to swim the Serpentine mile which I did last year.' (S10 Outdoor swimmer)* *'I knew if I was going to do indoor swimming I was going to have to compete at the masters, I knew I would have to have a goal to measure myself by and all my sports have been the same.' (S4 Pool and outdoor swimmer)*		

Appendix H: Health Questionnaire

This short questionnaire has been designed to help me assess whether swimming is a suitable form of exercise for you. If you are unsure about any of the questions, please email me

Heart Do you have a heart condition, do you ever suffer from pain in your chest when you exercise? *Heart conditions might include angina, heart failure, previous heart surgery, previous heart attack or having a pacemaker*

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes or unsure, please comment

Blood Have you suffered from a blood clot (e.g. DVT in your leg or PE in your lung), a stroke or do you take blood thinners or have a blood clotting disorder?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes or unsure, please comment

Blood pressure Do you suffer from high or low blood pressure, or do you take medication to manage your blood pressure? Do you have an aneurysm (a defect in an artery)?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes or unsure, please comment

f you have recently had your blood pressure measured, please add the result below

Breathing Do you have a condition that would affect your breathing? For example, you have a chest infection, asthma, COPD, you are short of breath at rest or on exertion

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes or unsure, please comment

Do you suffer from **diabetes**?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes or unsure, please comment

Do you suffer from dizzy spells, poor balance, fits, seizures, or fainting?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes or unsure, please comment

Have you had an operation, radiotherapy, or chemotherapy in the last 3 months?

- [ ] Yes
- [ ] No
- [ ] Unsure

If yes or unsure, please comment

Bladder and bowel Do you suffer from incontinence? Have you had vomiting and/or diarrhoea in the last 48 hours?

- [ ] Yes
- [ ] No
- [ ] Unsure

If yes or unsure, please comment

Do you already do regular exercise or activities in which you are physically active?

- [ ] Yes
- [ ] No
- [ ] Unsure

If yes, please let me know what type of exercise or how you keep physically active.

What is your current weight and height? *(If you do not know your current weight or height or you would prefer not to say please leave this section blank)*

Do you suffer from fatigue?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes or unsure, please comment

Do you have a visual or hearing impairment? Do you have hearing aids or grommets? Would you need to wear glasses in a pool?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes or unsure, please comment

Is there any medication you will require to be kept on the poolside e.g. asthma pump, angina spray?

- ☐ Yes
- ☐ No
- ☐ Unsure

Do you use a walking aid (a stick, crutch, or wheeled walker)? Will you need to use this to get to the pool?

- ☐ Yes
- ☐ No
- ☐ Unsure

Are you worried about falling or slipping in the pool area or changing room? If yes, what can we do to help?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes or unsure, please comment

Is there anything else you would like to tell me about your general health? (optional)

Thank you very much for completing this questionnaire, please contact me if you have any questions or concerns

Appendix I: Back Pain Questionnaire

This short questionnaire has been designed to help me understand your back pain and what you hope to achieve by joining this swimming class. Although I refer to the condition as 'back pain' in this questionnaire, it is recognised that people with this condition do not just experience pain in the low back. Physically people with back pain often have less movement in their spine, some people can become fearful of movement, their spine can feel compressed, they may have weakness of their core, leg and arm muscles and suffer from fatigue. Some people with back pain can also experience nerve pain in their leg, commonly known as sciatica. Back pain can also have a social impact and can affect someone's mental health. With this in mind, I would like you to consider all aspects of persistent back pain when completing this questionnaire.

Have you been given a diagnosis or cause for your back pain? If so, what is it?

How long have you had your back pain?

Where is your pain located?

How would you describe your back pain?

What activities or positions can make your back worse?

What activities or positions can make your back better?

How easy is it to provoke or increase your back pain? Do you get frequent flare ups?

How mobile is your back? Which back movements are restricted?

Do you have restrictions in the movement of any other joints in your body, if so which ones?

Do you have a foot drop or weakness in certain muscles due to your back condition?

Has you back pain had an impact on your mental health?

What have you already tried for your back pain, and did it help?

If you have seen another health professional for your back pain, what did they recommend?

Have you received any advice about being cautious about certain activities?

Do you have osteoporosis or osteopenia? (low bone density)?

Are you someone who tends to avoid or push too hard with exercise?

How is your back after exercise (please specify the exercise you are referring to)?

What do you hope to achieve by trying this swimming class? *e.g. I hope that swimming will reduce my back pain, that I will gain more movement, that my fitness will improve, that I will be able to manage a healthier weight, that my mental health will improve.*

Is there anything else you would like to tell me about your back pain? (optional)

Thank you very much for completing this questionnaire, please contact me if you have any questions or concerns.

Appendix J: Swimming Ability Questionnaire

This short questionnaire has been designed to help me understand more about your swimming ability and experience.

Can you swim aided?

- ☐ Yes
- ☐ No
- ☐ Unsure

How far could you swim without stopping? (in metres) For *the purpose of this questionnaire, please assume that one length of a pool is 25 metres.*

What is you preferred stroke for your back?

Can you swim front crawl?

- ☐ Yes
- ☐ No
- ☐ Unsure

Can you swim backstroke?

- ☐ Yes
- ☐ No
- ☐ Unsure

Can you swim breaststroke?

- ☐ Yes
- ☐

No

☐ Unsure

Can you swim any other stroke, if so which stroke?

Are you comfortable in deep water?

☐ Yes

☐ No

☐ Unsure

Can you tread water (swim on the spot vertically)?

☐ Yes

☐ No

☐ Unsure

Can you put your face in the water and breathe out?

☐ Yes

☐ No

☐ Unsure

Would you normally use goggles to swim?

☐ Yes

☐ No

☐ Unsure

Can you enter and exit the water without assistance? If you can't what help will you require?

☐ Yes

☐ No

☐ Unsure

Can you float unaided?

☐ Yes

☐ No

☐ Unsure

Do you have any fears, phobias or worries about swimming or being in the water, have you ever had a bade experience in the water.

☐ Yes

☐ No

☐ Unsure

If yes or unsure, please comment. If you would prefer to talk in person about this please let me know.

When was the last time you swam?

How often have you swum in the last few months?

Have you had swimming lessons as an adult?

☐ Yes

☐ No

☐ Unsure

How do you feel in warmer or colder water, what temperature is best for you?

Is there anything else you would like to tell me about your swimming ability and experience (Optional)

Thank you very much for completing this questionnaire, please contact me if you have any questions or concerns.

Appendix K: Oswestry Low Back Pain Disability Questionnaire

Instructions: Please circle **ONE NUMBER** in each section which most closely describes your problem.

Section 1- Pain Intensity

0. I can tolerate the pain I have without having to use pain medication.
1. The pain is bad, but I can manage without having to take pain medication.
2. Pain medication provides me with complete relief from pain.
3. Pain medication provides me with moderate relief from pain.
4. Pain medication provides me with little relief from pain.
5. Pain medication has no effect on my pain.

Section 2- Personal Care (Washing, Dressing, etc.)

0. I can take care of myself normally without causing increased pain.
1. I can take care of myself normally, but it increases my pain.
2. It is painful to take care of myself and I am slow and careful.
3. I need help, but I am able to manage most of my personal care.
4. I need help every day in most aspects of my care.
5. I do not get dressed, I wash with difficulty, and I stay in bed.

Section 3- Lifting

0. I can lift heavy weights without increased pain.
1. I can lift heavy weights, but it causes increased pain.
2. Pain prevents me lifting heavy weights off the floor, but I can manage if they are conveniently positioned (i.e., on a table).
3. Pain prevents me lifting heavy weights off the floor, but I can manage light to medium weights if they are conveniently positioned.
4. I can lift only very light weights.
5. I cannot lift or carry anything at all.

Section 4- Walking

0. Pain does not prevent me from walking any distance.
1. I cannot walk more than 1 mile without increasing pain.
2. I cannot walk more than 1/2 mile without increasing pain.
3. I cannot walk more than 1/4 mile without increasing pain.
4. I can walk only with crutches or a cane.
5. I cannot walk at all without increasing pain.

Section 5- Sitting

0. I can sit in any chair as long as I like.
1. I can only sit in my favourite chair as long as I like.
2. Pain prevents me from sitting more than 1 hour.
3. Pain prevents me from sitting more than 1/2 hour.
4. Pain prevents me from sitting more than 10 minutes.
5. I avoid sitting because it increases pain immediately.

Section 6- Standing

0. I can stand as long as I want without pain.
1. I have some pain on standing but it does not increase with time.
2. I cannot stand for longer than 1 hour without increasing pain.
3. I cannot stand for longer than 1/2 hour without increasing pain.
4. I cannot stand for longer than 10 minutes without increasing pain.
5. I avoid standing because it increases pain immediately.

Section 7- Sleeping

0. Pain does not prevent me from sleeping well.
1. I can sleep well only by using pain medication.
2. Even when I take medication, I sleep less than 6 hours.
3. Even when I take medication, I sleep less than 4 hours.
4. Even when I take medication, I sleep less than 2 hours.
5. Pain prevents me from sleeping at all.

Section 8- Social Life

0. My social life is normal and does not increase my pain.
1. My social life is normal, but it increases the degree of pain.
2. Pain prevents me from participating in more energetic interests (i.e., sports, dancing, etc).
3. Pain has restricted my social life and I do not go out very often.
4. Pain has restricted my social life to my home.
5. I have hardly any social life because of my pain.

Section 9- Traveling

0. I can travel anywhere without increased pain.
1. I can travel anywhere, but it increases my pain.
2. My pain restricts my travel over 2 hours.
3. My pain restricts my travel over 1 hour.
4. My pain restricts my travel to short necessary journeys under ½ hour.
5. My pain prevents all travel except for visits to the physician/therapist or hospital.

Section 10- Employment/Homemaking

0. My normal homemaking/job activities do not cause pain.
1. My normal homemaking/job activities increase my pain, but I can still perform all that is required of me.
2. I can perform most of my normal homemaking/job duties, but pain prevents me from performing most physically stressful activities (i.e., lifting, vacuuming, etc).
3. Pain prevents me from doing anything but light duties.
4. Pain prevents me from doing even light duties.
5. Pain prevents me from performing any job or homemaking chores.

Appendix L: Pain Self-efficacy Questionnaire

Please rate how **confident** you are that you can do the following things at present, **despite the pain**. To indicate your answer circle one of the numbers on the scale under each item, where 0 = not at all confident and 6 = completely confident.

Remember, this questionnaire is not asking whether or not you have been doing these things, but rather how confident you are that you can do them at present, despite the pain.

1. I can enjoy things, despite the pain.

   0 1 2 3 4 5 6

   Not at all confident Completely Confident

2. I can do most of the household chores (e.g., tidying-up, washing dishes, etc.), despite the pain.

   0 1 2 3 4 5 6

   Not at all confident Completely Confident

3. I can socialise with my friends or family members as often as I used to do, despite the pain.

   0 1 2 3 4 5 6

   Not at all confident Completely Confident

4. I can cope with my pain in most situations.

   0 1 2 3 4 5 6

   Not at all confident Completely Confident

5. I can do some form of work, despite the pain. (“work” includes housework, paid and unpaid work).

   0 1 2 3 4 5 6

   Not at all confident Completely Confident

6. I can still do many of the things I enjoy doing, such as hobbies or leisure activity, despite pain.

   0 1 2 3 4 5 6

Not at all confident Completely Confident

7. I can cope with my pain without medication.

0 1 2 3 4 5 6

Not at all confident Completely Confident

8. I can still accomplish most of my goals in life, despite the pain.

0 1 2 3 4 5 6

Not at all confident Completely Confident

9. I can live a normal lifestyle, despite the pain.

0 1 2 3 4 5 6

Not at all confident Completely Confident

10. I can gradually become more active, despite the pain.

0 1 2 3 4 5 6

Not at all confident Completely Confident

Appendix M: EQ-5D-3L

Under each heading, please tick the ONE box that best describes your health TODAY.

MOBILITY

I have no problems in walking about ❑

I have some problems in walking about ❑

I am confined to bed ❑

SELF-CARE

I have no problems with self-care ❑

I have some problems washing or dressing myself ❑

I am unable to wash or dress myself ❑

USUAL ACTIVITIES *(e.g., work, study, housework, family, or leisure activities)*

I have no problems with performing my usual activities ❑

I have some problems with performing my usual activities ❑

I am unable to perform my usual activities ❑

PAIN / DISCOMFORT

I have no pain or discomfort ❑

I have moderate pain or discomfort ❑

I have extreme pain or discomfort ❑

ANXIETY / DEPRESSION

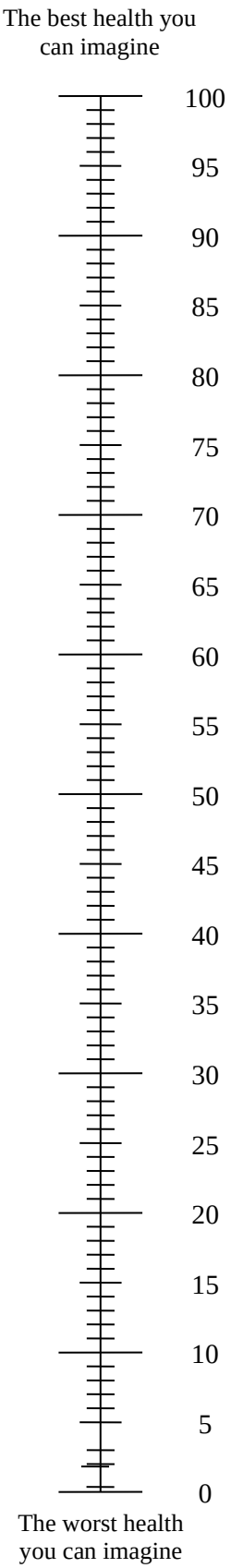
I am not anxious or depressed ❑

I am moderately anxious or depressed ❑

I am extremely anxious or depressed ❑

YOUR HEALTH TODAY = ☐

- We would like to know how good or bad your health is TODAY.
- This scale is numbered from 0 to 100.
- 100 means the best health you can imagine.
  0 means the worst health you can imagine.
- Please mark an X on the scale to indicate how your health is TODAY.
- Now, write the number you marked on the scale in the box below.



Appendix N: Follow-up Questionnaire after Swimming Programme Study Four

Welcome

This short questionnaire aims to find out about your experience of this program of swimming lessons. Your feedback will be used to improve the lessons for future participants.

Many thanks for your interest and time.

Set up of swimming class

These questions are asking about your thoughts on the set up of the swimming class.

The swimming lessons lasted 30 minutes; do you agree that this was the right length of time for someone with back pain?

- ☐ Yes
- ☐ No
- ☐ Unsure

Comments (optional)

You were offered 6 swimming lessons; do you agree that this was the right number of lessons for someone with back pain?

- ☐ Yes
- ☐ No
- ☐ Unsure

Comments (optional)

The swimming lessons were delivered to 5 people at the same time; do you agree that this was the right number of people in the class?

- ☐ Yes
- ☐ No
- ☐ Unsure

Comments (optional)

Your experience of the swimming lessons

These questions are asking about your experience of this program of swimming lessons

Which swimming stroke did you mainly work on during the swimming lessons?

- ☐ Front crawl
- ☐ Backstroke
- ☐ Breaststroke

Comments (optional)

Did you find that the swimming lessons were adapted for you and your back pain?

- ☐ Yes
- ☐ No
- ☐ Unsure

Comments (optional)

During the swimming lessons and whilst in the water were you able to do...

- ☐ More than you can usually do
- ☐ About the same amount as you can usually do
- ☐ Less than you can usually do

Comments (optional)

After the swimming lessons (later that day) were you able to do...

- ☐ More than you can usually do

- [ ] About the same amount as you can usually do
- [ ] Less than you can usually do

Comments (optional)

Do you have back pain, leg pain or both back and leg pain?

- [ ] Back pain
- [ ] Leg pain
- [ ] Both back and leg pain

Comments (optional)

During the swimming lessons and whilst in the water did you find that your pain was

- [ ] Worse
- [ ] No different
- [ ] Easier
- [ ] I had no pain while in the water

Comments (optional)

After the swimming lessons (later that day) did you find that your pain was

- [ ] Worse
- [ ] No different
- [ ] Easier
- [ ] I had no pain after the swimming lesson

Comments (optional)

Is there anything you would like to be added to the swimming lessons?

- [ ] Yes
- [ ] No

☐ Unsure

Comments (optional)

Are there any parts of the swimming lessons you think should not be included in future swimming lessons?

☐ Yes
☐ No
☐ Unsure

Comments (optional)

Future plans with swimming

These questions are asking about your future plans with swimming now that you have finished this program of swimming lessons

In the next month how often will you intend to go swimming?

☐ I am not intending to go swimming

☐ 1-2 times

☐ 3-4 times

☐ 5-6 times

☐ 7-8 times

☐ more than 8 times

Comments (optional)

Would any of these factors stop you from going to the swimming pool? (Please tick all that apply)

- ☐ Lack of time
- ☐ The cost of swimming
- ☐ It may be difficult for me to get to the pool (car / bus)
- ☐ If I can't park close to the pool
- ☐ If I struggle to get changed
- ☐ If it is difficult for me to get from the changing room to the pool
- ☐ If I am worried about falling or slipping in the pool area or changing room
- ☐ If I find it difficult getting in and out of the pool
- ☐ If the pool is too cold

Comments (optional)

Would any of these factors stop you using swimming as a form of exercise? (Please tick all that apply)

- ☐ If I can't swim very well
- ☐ If I have a fear of water
- ☐ If I am worried that swimming will make my back pain worse
- ☐ If I have more back pain while swimming
- ☐ If my back pain is worse after swimming
- ☐ If I am unsure which swimming stroke is best for my back pain
- ☐ If I don't enjoy swimming
- ☐ If I lack motivation to go swimming
- ☐ If I feel uncomfortable wearing a swimming a costume or trunks
- ☐ If I have a medical reason that stops me swimming
- ☐ If I experience an adverse reaction to swimming in a pool (e.g. ear irritation)

Comments (optional)

Would any of these factors help you continue to swim on a regular basis? (please tick all that apply)

- ☐ If I had less back pain when I was in the pool
- ☐ If I found that swimming eased my back pain
- ☐ If I believed that swimming was good for my back
- ☐ If I found that I was able to do more in the water
- ☐ If I found that I was able to do more during the week
- ☐ If I continued to take a swimming class
- ☐ Choosing to go with a friend or family member
- ☐ If I noticed that my general health and fitness improved
- ☐ If I noticed that my mood and wellbeing improved
- ☐ If I noticed that my muscle strength and flexibility improved
- ☐ If I set goals and made an action plan
- ☐ If I found that swimming helped me to maintain a healthy weight for me
- ☐ If a health professional advised me to go swimming
- ☐ If I was eligible for a discount on swimming fees

Comments (optional)

Would you recommend this swimming class to a friend or family member?

- ☐ Yes
- ☐ No
- ☐ Unsure

Comments (optional)

Do you have any other feedback you would like to share about the swimming class?

Comments (optional)

Final page

Thank you very much for participating in this study; we will be in touch again in 6 months to find out how you are and whether you are still swimming.

If you have any queries, please contact me on

Appendix O: 6-month Follow-up Questionnaire Study Four

Welcome

This questionnaire aims to find out:

- Whether you have been swimming since completing the swimming class
- Whether your swimming ability is improving
- Your experience of swimming with back pain
- Whether you have been trying other forms of exercise other than swimming

Your feedback and suggestions will be used to improve the class for future participants. Many thanks for your interest and time.

Did you swim after the class

Over the last month how often have you been swimming?

- ☐ I have not been swimming
- ☐ 1-2 times
- ☐ 3-4 times
- ☐ 5-6 times
- ☐ 7-8 times
- ☐ More than 8 times

Comments (optional)

Which pool or pools have you swum in?

If you have been swimming, please can you tell us the reasons why you have swum

If you have not been swimming, please can you tell us the reasons why you have not swum

Swimming ability

How many lengths of a pool would you be able to swim front crawl without stopping (based on a 25m pool) since completing the series of swimming class?

- ☐ I cannot swim front crawl
- ☐ Less than a length or width
- ☐ 1 length
- ☐ 2 lengths
- ☐ 4 lengths
- ☐ 8 lengths

Is your ability to swim front crawl further limited by your back pain, your fitness, your general health, your ability to swim this stroke or due to other reasons?

- ☐ Back pain
- ☐ Fitness
- ☐ General health
- ☐ Ability to swim stroke
- ☐ Other reasons

How many lengths of a pool would you be able to swim backstroke without stopping (based on a 25m pool) since completing the series of swimming class?

- ☐ I cannot swim backstroke
- ☐ Less than a length or width
- ☐ 1 length
- ☐ 2 lengths
- ☐ 4 lengths

- [ ] 8 lengths

Is your ability to swim backstroke further limited by your back pain, your fitness, your general health, your ability to swim this stroke or due to other reasons?

- [ ] Back pain
- [ ] Fitness
- [ ] General health
- [ ] Ability to swim stroke
- [ ] Other reasons

How many lengths of a pool would you be able to swim breaststroke without stopping (based on a 25m pool) since completing the series of swimming class?

- [ ] I cannot swim breaststroke
- [ ] Less than a length or width
- [ ] 1 length
- [ ] 2 lengths
- [ ] 4 lengths
- [ ] 8 lengths

Is your ability to swim breaststroke further limited by your back pain, your fitness, your general health, your ability to swim this stroke or due to other reasons?

- [ ] Back pain
- [ ] Fitness
- [ ] General health
- [ ] Ability to swim stroke
- [ ] Other reasons

Comments (optional)

Swimming and back pain

While swimming I find that my back pain is

- ☐ Worse
- ☐ No different
- ☐ Better
- ☐ I have no back pain while in the water

Comments (optional)

After the swimming (later that day) I find that my back pain is

- ☐ Worse
- ☐ No different
- ☐ Better
- ☐ I have no back pain after the swimming

Comments (optional)

While swimming I feel that I am able to do

- ☐ More than I can usually do
- ☐ About the same amount as I can usually do
- ☐ Less than I can usually do

Comments (optional)

After swimming I feel that I am able to do

- ☐ More than I can usually do
- ☐ About the same amount as I can usually do
- ☐ Less than I can usually do

Comments (optional)

Other exercise

Have you done any other exercise in the water other than swimming, for example aqua jogging, walking in the water? Please tell us what you have tried.

Comments (optional)

Over the last 6 months have you started any new forms of exercise that you were not doing prior to the swimming classes

- ☐ Walking
- ☐ Cycling
- ☐ Gym
- ☐ An exercise class
- ☐ Aqua aerobics
- ☐ Running
- ☐ Other

Comments (optional)

Other comments

Do you have any other feedback you would like to share about the swimming class and your experience swimming with back pain.

Comments (optional)

Thank you very much for participating in this study!
If you have any queries or wish to discuss the findings from the study, please contact me on

Appendix P: Six Session Plans Study 4

Session brief prior to first session.

It is assumed that the following would be included prior to any swimming class; safety information, housekeeping, water temperature, depth, safety procedures, register changes in health, back pain, and wellbeing, are they well hydrated and when did they last eat. How to enter and exit water and summon help. Introduction to the type of session, session plan, which strokes, aims, objectives and the time the session will run.

- Explain why using **swimming as a rehabilitation tool**, the benefits, and problems with this type of approach and any guidelines. Include some discussion about not knowing which swimming stroke is best for back pain. Hopefully by the end of the class the swimmers will have developed a better understanding of what stroke(s) are best for their back. Also talk about the wider benefits of swimming such as impact on weight and mental health and how this could help in the management of their back pain.
- Discuss any **concerns, fears, and barriers**; in relation to back pain, swimming or being in the water
- Discuss **what to expect** and what is normal during and after a swim. They might experience some discomfort, mild shortness of breath and muscle fatigue; they should alert the teacher if they experience a significant increase in back pain or they feel unwell. Discuss pacing and when they should rest /pause between activities or lengths. Discuss their expectations; what do they want to achieve from the session

Session one			
Session aim: Learning how to be safe and feel relaxed when in the water			
Learning Objectives • To learn how to enter and exit the water using the most comfortable and safe method for them • To develop aquatic breathing skills • To learn how to stand up from supine and prone position • To learn to glide and move in a streamline way with and without flutter kick • To develop a feel for the water through sculling		**Learning Outcomes** • Swimmer able to enter and exit the water using the most comfortable and safe method for them • Swimmer comfortable putting face in the water • Swimmer able to stand up from supine and prone position	
Session section and time	**Activity**	**Teaching points**	**Comments**
Session brief (5 mins)	• *Safety information, housekeeping, water temperature, depth, safety procedures.* • *Register changes in health, back pain, and wellbeing, are they well hydrated and when did they last eat.* • *How to enter and exit water and summon help.* • *Introduce the session objectives and planned activities.*	Ensure that everyone arrives 10 minutes early so brief can be at same time	
Entry and exit (1 mins entry at start and 1 min exit at cool down)	• Try different methods entering and exiting the water, finding out which feels the most comfortable and safe method for them. They might need to make changes to accommodate for back pain, loss of strength and mobility and other conditions (e.g., OA knee).	• Methods could include using the steps, ladders, sliding in and climbing out, using a ramp or hoist. • Entry and exit to the pool could be independent or with the help of the pool staff or a carer, friend or relative	

		• Warn that they might feel a sense of heaviness leaving the pool	
Water based warm up (5 mins)	• Walking in the water forwards and sideways; getting used to the sensation of the water and the feeling of weightlessness. • Walk in a circle around the edge of the pool holding woggles, this allows them to understand the different depths of the pool and it gets them moving.	• Awareness exercise: Ask them to consider how their movement in the water feels compared to on land. • Options: the swimmers could hold onto the pool side, bar, or a woggle. • Watch which swimmers are nervous or unsteady and require closer supervision	
Core Aquatic skill 1 (4 mins) **Aquatic breathing**	• Discuss concerns about putting face in water such as feeling claustrophobic or a previous bad experience. • Learn how to fit and wear goggles so able to relax when breathing in water. • **Practice scooping water with hands to wet face** • **Breathing exercises** holding onto poolside, first with head out and in then in the water, blowing bubbles.	• Awareness exercise: ask them to compare breathing out through mouth and nose. • Fitting the goggles could be done on the side before getting in the pool.	
Core Aquatic skill 2 (4 mins) **Changing position in the water**	• Learn how to stand up in water from supine and prone positions, lifting head, bringing knees towards trunk (an essential safety skill in the water). Could initially do this with a woggle.	• If supine the woggle should be behind and if prone that the woggle should be in front so not to impede movement • Awareness of using the core muscles during when changing position in the water, slowly exhaling, and relaxing the spine to allow body to move freely.	

		• Cues could include bring knees to chest. • Awareness how changing position feels different in the water when compared to being on dryland.	
Core Aquatic skill 3 (4 mins) **Gliding**	• Learning to glide and move in a streamline way, trying different head, body, arm, and leg positions in the water, feeling which ones are more comfortable for back and which improve the efficiency and speed of the movement through the water. • Practice gliding in 2 positions; front and side	• Remind swimmer to exhale slowly during glide • Add small float (kickboard or woggle) if necessary • If nervous the teacher could hold the float / woggle • Check head position in glide to ensure less strain on neck	
Lumbar flexion stretch holding onto the side, with or without woggle – discuss why this might be a useful stretch (1 min)			
Front crawl 1 (5 mins): **Legs**	• Standing on toes on one foot practice correct leg action in standing. • Progress to practicing a small flutter kick to glide whilst on front and then on side	• Keep kick small, move leg from hip not back or knee • Remind swimmer to exhale slowly whilst face in water as breath holding can alter position in the water. • Awareness exercise: does the kick feel more comfortable when they are on their side or front	
Front crawl 2 (5 mins): **Sculling and arms**	• Develop a **feel for the water** with hands through sculling, feel how core muscles are recruited with this movement. • Try sculling movements whilst standing in the water. • Practise front crawl arm action in standing, feel the 'catch' at the start of the pull phase • Progress to walking whilst practicing arms	• Teacher to demonstrate both the sculling and front crawl arm action • Awareness exercise: feel the hand catch the water at the start of the pull phase, pull back not down	

Cool down and exit (3 mins)	Repeat flexion stretches and practice exits	• See above on entry and exit section	
Session debrief and tools to help the participant become a lifelong swimmer (5 mins)	• What to expect • Teaching points • Positive feedback • What to work on this week? • Reflection **Tool 1**: Information about access to local pools and cost. Information about changing facilities. Discuss about taking time to prepare to get in the water and to leave the venue.	• Example of what to work on this week: • Single leg kick on step • Have information available about the pool you are using • Allow sufficient time for showering and changing	

Session two			
Session aim: Learning how to adopt a more streamline position in the water			
Learning Objectives: • To develop aquatic breathing skills • To learn how to glide and change position in the water with and without kick • To develop a feel for the water through sculling • Introduce front crawl arms with or without body rotation • To develop a more streamline position in the water during front crawl • To introduce breaststroke, kick on back		**Learning Outcomes:** • Swimmer able to control breathing when face in the water • Swimmer able to change position in the water from front to side to back • Swimmer able to scull in one position for 20 seconds • Swimmer able to swim 3 strokes front crawl from a glide	
Session section and time	**Activity**	**Teaching points**	**Comments**
Session brief (5 mins)	*Introduce the session objectives and planned activities and register changes in health, back pain, and wellbeing.* *Find out how they were after the first session and record notes on lesson plan*		
Water based warm up (3 mins)	• Walking and / or jumping in the water different directions • Use woggle, side or scull while moving • Discovering which direction is most comfortable for them. • Archers stretch	• Awareness exercise: ask the swimmers which muscle groups they feel are working and how the position of their back changes when they move in different directions. • If they have nerve symptoms in their leg ask them how this is affected when they walk different directions in the water,	

		do they feel better with a shorter stride length? • Can split group into more able and less able swimmers	
Core Aquatic skill 1 (4 mins) **Aquatic breathing**	• **Breathing exercises** holding onto poolside or a float first with head out and in then in the water, blowing bubbles. • Can try saying a word into the water to control exhalation • Trialling a nose clip, do they prefer this or without	• Awareness exercise: ask them to compare different speeds and depths of inhalation and exhalation. • Discuss how over breathing can lead to shortness of breath and panic when swimming • Discuss how effective breathing whilst swimming can be used to manage anxiety, pain, to help focus on the present moment and to swim with less shortness of breath • Could reduce time spent on this section with more able swimmers	
Core Aquatic skill 2 (4 mins) **Gliding and changing position**	• Practice gliding on front and side • Practice changing position in water from side, front and back during glide	• Remind swimmer to exhale slowly during glide • Awareness how changing position feels different in the water when compared to being on dryland, appreciate that the movement should feel easier • Could reduce time spent on this section with more able swimmers	

Core Aquatic skill 3 (4 mins) **Sculling (vertical)**	• Develop **a feel for the water** with hands through sculling, feel how core muscles are recruited with this movement • Try sculling movements whilst standing in the water • Try sculling in a vertical position with a woggle • Try sculling on back with breaststroke legs	• Could try this exercise with a hand paddle to enhance the feel for the water • Could make the sculling with a woggle a group challenge, who can travel the furthest	
Lumbar flexion stretch, streamline position stretch (1 min)			
Front crawl 1 (5 mins) **Legs with fins**	• Review correct kick standing as before. • Glide on side into kick with fins or without if not comfortable	• Could try with or without a float • Kick from hips and not from their back or knees • Fins may make it easier for swimmer to maintain a streamline position due to increase in propulsion, only use fins if struggling with propulsion and staying afloat	
Front crawl 2 (5 mins) **Single arm and / or both arms with rotation**	• Stand up in water and check mobility of shoulders, practice a streamline position in standing • If poor mobility show how could adapt front crawl arm to an underwater recovery • Rehearse single arm in standing • Practice 3-4 single or both arms from glide and stand • Integrate rotation of trunk to this exercise	• Pull hand towards you, not down • **Practice rotation** of the trunk during front crawl so that the whole body rotates. • Move smoothly through water using this rotation. • Use a woggle with the more nervous swimmers if necessary • With more able swimmers could look at whole stroke at this stage and ways to improve technique; for example, timing of breathing,	

	• The swimmer can glide on their side with their arm starting on their hip to optimise rotation during first stroke.	head position, rotation of body during stroke	
Cool down and exit (5 mins)	• Lumbar flexion stretch if required • Try breaststroke kick on back with woggle or standard backstroke or old English backstroke	• Keep hips low in water • Hold glide phase of kick • Rehearse arms in standing • If less mobility in shoulder adapt arm pull • Try different body positions on back, do they help you float, how do they feel on your back	
Session debrief and tools to help the participant become a lifelong swimmer (5 mins)	• What to expect • Teaching points • Positive feedback • What to work on this week? • Reflection **Tool 2**: Consider setting goals, being comfortable prioritising self so able to swim regularly and learning how to make a written action plan	Example of what to work on this week:	

Session three			
Session aim: Learning how to rotate body in the water and use arms			
Learning Objectives • To learn how to float in a comfortable position • To learn how to do front crawl arms with body rotation, if comfortable for back • To develop a more streamline position in the water during front crawl • Introduce backstroke		**Learning Outcomes** • Swimmer able to float for 5 seconds in a comfortable position • Swimmer able to rotate body during front crawl, if comfortable for back • Swimmer able to travel further when gliding and swimming with less effort and less resistance	
Session section and time	**Activity**	**Teaching points**	**Comments**
Session brief (5 mins)	*Introduce the session objectives and planned activities and register changes in health, back pain, and wellbeing.* *Find out how they were after the last session and record notes on lesson plan*		
Water based warm up (3 mins)	• Walking while doing sculling movements with arms, using the direction that they felt most comfortable with during the last session. • Sculling whilst sitting on woggles	• Awareness activity: explain how using the sculling action can help warm up arms before swimming and improve their 'feel for the water.'	
Core Aquatic skill 1 (4 mins) **Floating**	• Learning how to float on back and front with or without a woggle. • Trying different head, body, arm, and leg positions in water, feeling	• Remind swimmer to relax and breathe while floating in the water, this will improve ability to float	

	which ones are more comfortable for their back.	• Nervous swimmers could hold onto the side or onto a woggle or the teacher • If unable to float stationary could float with a glide • On front could try a mushroom float • Which position do they feel more comfortable floating? • Explain how trying to balance when floating can increase core strength. • Remind that floating can be used to relax, deal with panic in the water, pain or if they are experiencing cramp.	
Core Aquatic skill 2 (4 mins) **Gliding with kick +/- fins**	• Practice gliding with kick on side with or without fins.	• Keep kick small and from hips, not back or knees • Awareness exercise; feel difference to body with extra propulsion from fins • Remind to breathe and not hold breath • Can look at why some people travel further when gliding and what changes can be made to improve ability to glide, e.g., trying different head, body, arm, and leg positions in the water, feeling which ones are more comfortable for back and which improve the efficiency and	

		speed of the movement through the water	
Lumbar flexion stretch and archer (1 min)			
Front crawl (3 mins) **Single arm with rotation**	• Rehearse single arm in standing • Practice 3 single arms from glide and stand • Integrate rotation of trunk to this exercise • Start from glide on side with their arm starting on hip to optimise rotation during first stroke. • The more able swimmers may not need to practice this again	• Pull hand towards you, not down • **Practice rotation** of the trunk during front crawl so that the whole body rotates • Don't worry about the breathing to the side just slowly exhale in the water • Move smoothly through water using this rotation	
Front crawl (8 mins) **Both arms with rotation**	• The less able swimmers may need to rehearse both arms in standing • Integrate rotation of trunk to this exercise • Practice 3-4 arms (both) from glide and stand for the less able swimmers • Start from glide on side with their arm starting on hip to optimise rotation during first stroke. • The more able swimmers can work on technique for example, timing of breathing, head position, rotation of body during stroke, arm entry, catch	• Don't worry about the breathing to the side just slowly exhale in the water • **Practice rotation** of the trunk during front crawl so that the whole body rotates. • Can be reciprocal or catch-up style • Awareness exercise: do they feel better using front crawl to improve the rotation in spine or is it more comfortable to rotate the whole body?	

Backstroke or Old English Backstroke (5 mins)	• Old English or traditional back stroke	• Keep hips low in water • Hold glide phase of kick • Could use woggle for old English backstroke and double arms or sculling • Work on body position during glide and keeping head still with shoulders rotating (traditional stroke) • Be aware of marks on the ceiling and when to stop (close to wall)	
Cool down and exit (4 mins)	Going underwater to pick up sinkers, and if they are confident a handstand Stretches such as Lumbar flexion stretch (wall or mushroom float), shoulder horizontal flexion and triceps	• Use fun activities to improve confidence in back	
Session debrief and tools to help the participant become a lifelong swimmer (5 mins)	• What to expect • Teaching points • Positive feedback • What to work on this week? • Reflection **Tool 3:** Time to reflect on other benefits of swimming, beyond their back pain, such as improvements in fitness, general health, wellbeing, mood, general muscle strength and flexibility, and being better able to manage a healthy weight.	Example of what to work on this week:	

Session four			
Session aim: Learning how to breathe during stroke cycle			
Learning Objectives • To develop a feel for the water through sculling • To learn to be in the present moment when they are in the water • To learn to breathe during stroke cycle • To develop a flatter style of breaststroke with a slower stroke turnover and longer glide.		**Learning Outcomes** • Swimmer able to be in the present moment during time in pool • Swimmer able to take breath during stroke cycle	
Session section and time	**Activity**	**Teaching points**	**Comments**
Session brief (5 mins)	*Introduce the session objectives and planned activities and register changes in health, back pain, and wellbeing.* *Find out how they were after the last session and record notes on lesson plan*		
Water based warm up (3 mins)	• Sitting on noodles and pass the ball around the group	• Explain the value of warming up gradually, how it can help reduce injuries and get your body ready for exercise • Incorporate a fun activity at the start, to improve confidence	
Core Aquatic skill 1 (4 mins) **Sculling**	• Develop **a feel for the water** with hands through sculling, a quick practise of sculling movements whilst standing in the water and then try sculling whilst lying on back	• Add a woggle if struggling to float • Awareness exercise: feel how core muscles are recruited whilst sculling.	
Core Aquatic skill 2 (4 mins) **Being in the present moment and enjoying being in the water**	• Learning to be in the present moment during swim and not thinking about what they need to do next and what has happened before.	• **Awareness exercises:** focus on the ease of movement through the water, feeling weightless and the bubbles in the water	

	• Practice gliding off the wall under water to pick up sinker		
Lumbar flexion and horizontal flexion shoulder stretch (1 min)			
Front crawl (5 mins) **Both arms with rotation and breathing for less able swimmers or improving technique for more able swimmers**	Less able swimmers • Rehearse both arms in standing • Integrate rotation of trunk to this exercise • Practice 3-4 arms (both) from glide and stand • Start from glide on side with their arm starting on hip to optimise rotation during first stroke • Stroke could be reciprocal or catch up More able swimmers • Watch swimmer, look for areas that they could modify and improve their technique • Set and demo drills to work on these areas	• Don't worry about the breathing to the side just slowly exhale in the water • **Practice rotation** of the trunk during front crawl so that the whole body rotates. • Awareness exercise: Do they feel better using front crawl to improve the rotation in spine or is it more comfortable to rotate the whole body?	
Backstroke (5 mins)	• Work on glide first • Rehearse in standing • Make sure aware of point on ceiling so able to stand up in time	• Consider using a nose clip for backstroke • Consider timing of breath • Keep head still and rotate shoulders and bend elbow during propulsion phase	
Breaststroke (5 min)	• Practise breaststroke kick, face down from glide	• Hold glide and consider timing of breath • Hips in same position as when did breaststroke kick on back	

		• Awareness exercise: Being aware of the feeling of lengthening through trunk during glide phase • Remind the swimmer to exhale slowly	
Cool down and exit (4 mins)	Old English backstroke or floating or underwater swimming with or without sinkers and lumbar flexion stretch	• If they naturally float, try a floating exercise, if they sink an underwater exercise.	
Session debrief and tools to help the participant become a lifelong swimmer (5 mins)	• What to expect • Teaching points • Positive feedback • What to work on this week? • Reflection **Tool 4:** Discuss how to make swimming fun, enjoyable and sociable. What swimming groups could they join in the area.	Example of what to work on this week:	

Session five			
Session aim: Learning how to improve technique and adapt swimming stroke			
Objectives • To learn how to float on front • To learn how to tread water • To be able to problem solve how to make swimming more comfortable for their back • To be aware of teaching points and learn drills and exercises to improve technique		**Learning outcomes** • Swimmer able to float for 5 seconds on front • Swimmer able to tread water for 20 seconds • Swimmer able to independently adapt stroke for their back, this might change week to week. • Swimmer aware of 3 teaching points and drills to improve their technique	
Session section and time	**Activity**	**Teaching points**	**Comments**
Session brief (5 mins)	*Introduce the session objectives and planned activities and register changes in health, back pain, and wellbeing.* *Find out how they were after the last session and record notes on lesson plan*		
Water based warm up (3 mins)	• Walking with dynamic stretching; for example, high knees (marching), bending knees behind, lifting heels, with arm swings • Fun activity with ball in a circle; passing the ball; catch and turn, catch, and pass hand to hand and then combine the turn with the pass hand to hand.	• Awareness activity: feel how being in the water supports the body during these dynamic stretches and prepares the person for swimming. • Fun activity to improve confidence in back • The ball activity is using both sides of brain, preparing it for swimming	

Core Aquatic skill 1 (4 mins) **Floating**	• Learning how to float on front • Learning how to stretch whilst floating e.g., a mushroom float. •	• Remind swimmer to relax and slowly exhale while floating in the water. • If not confident could repeat floating on back exercise with or without a woggle. • Another option is glide and float	
Core Aquatic skill 2 (4 mins) **Treading water**	• **Learning how to tread water** in deep water with a float, just using legs. • Try breaststroke kick and learn eggbeater kick. • Add sculling with hands if able.	• Feel how a wide kick is more beneficial when they are in a vertical position. • Trying different arm and leg movements, feeling which movements are more comfortable for their back.	
Stretches: Swimmers choice (1 min)			
Front crawl (5 mins) **More practice with both arms with rotation and breathing** **Or exploring drills and equipment (more able swimmers)**	• Practise the breathing with the arms in standing • Start from glide on side with their arm starting on hip to optimise rotation during first stroke • Aim initially for 2 stroke cycles and then stand and reciprocal arms not catchup • More able swimmers to try different drills e.g., 6 kick roll, hand paddles, pull buoy, kicking on back with kickboard. Reflect on what felt comfortable for their	• Remind swimmer to exhale whilst face in the water and rotate body to breathe	

	back and why they would do that drill		
Choice stroke (5 mins) **Problem solving and improving technique**	•	• Work on specific areas to improve technique e.g., breathing timing, arm recovery, catch etc. • Make changes if necessary to accommodate for body, e.g., shoulder recovery could be underwater if restricted movement • Remind how altering position of head will affect leg and body position in the water e.g., if the head is too high the legs will drop. Some people will compensate by over kicking but this could increase lumbar extension. If head too low, then it may impact on breathing. Adjustments should be small	
Breaststroke / backstroke (5 mins)	• Try two kicks to one pull so that they are flatter for a longer period in the water.	• When face in the water look down • Remind swimmers to exhale when face in the water and to hold glide • Awareness exercise: knowing that you can swim different ratios of kick to pull if it feels better for your back	
Cool down and exit (4 mins)	Old English Backstroke with sculling and lumbar flexion and arm stretches		
Session debrief and tools to help the participant become a lifelong swimmer (5 mins)	• What to expect • Teaching points • Positive feedback • What to work on this week?	Example of what to work on this week:	

	• Reflection **Tool 5:** Discuss developing a peer support group with others in the class, using social media such as WhatsApp or Facebook.		

Session six			
Session aim: Enabling participant to continue to development as a swimmer and use swimming as back pain management tool			
Learning objectives • To understand the value of a warmup and have several activities they could use to warm up at the start of a swim • To learn how to change direction in the water at the end of the pool • To learn how to cope with a painful episode whilst swimming (e.g., cramp) • To set swimming goals and reflect on own progress		**Learning outcomes** • Swimmer understands the value of a warmup and has several activities they could use to warm up at the start of a swim • Swimmer able to turn by changing position and direction at end of pool • Swimmer able to indicate when they need support and get to the side or shallow water independently • Swimmer able to set a personal goal and be able to reflect on own progress	
Session section and time	**Activity**	**Teaching points**	**Comments**
Session brief (5 mins)	*Introduce the session objectives and planned activities and register changes in health, back pain, and wellbeing.* *Find out how they were after the last session and record notes on lesson plan*		
Water based warm up (3 mins)	• Sitting on woggles sculling down pool and back	• Reflection: will they carry on with a warmup when they swim independently? • Discuss why you should warm up before swimming e.g., prevention of shoulder problems • What alternatives could they consider e.g., a warmup at home, bands etc…	
Core Aquatic skill 1 (4 mins) **Changing direction in the water**	• Practice different ways of turning at the end of a length,	• Demonstrate a smooth slow turn at the wall	

	finding out which feels more comfortable.	• The more able swimmers could try a tumble turn; start with front to back push off version • If nerve damage affecting one leg, then look at how they could modify push off wall. • Awareness of using the core muscles during when changing position in the water and relaxing the spine to allow body to move freely.	
Core Aquatic skill 2 (4 mins) **Coping with a painful episode and recap**	• Practice how to indicate when they need support and get to the side or shallow water independently • Recap what they have learned during course to find out what they want to practice during last session	Review the following aquatic skills • Floating on back • Treading water • Sculling • Breathing and relaxation	
Stretches: Swimmers choice (1 min)			
Front crawl (5 mins) **Drills, exercises, and swimming equipment**	• With the more able swimmers look at some of the drills and exercises that they could use in the future when developing their front crawl technique, for example 6 kick roll, pulling. • Look at swimming equipment, how to use it and when it might be helpful • With the less able swimmers recap some of the skills they have learned such as the gliding, adopting a streamline	• Demo some equipment and allow them to try and see if it will help or aggravate their back pain e.g., pull buoy. Pulling with a pull buoy could increase lumbar extension in some swimmers but those whose legs who sink might benefit from this aid	

	body position, breathing control and kick		
Breaststroke or backstroke (5 mins)	• Add arms to kick, practising correct timing of arm to kick so maintain long glide. Initially only practice over one stroke cycle from a glide. • Learn to glide through the water smoothly (not ballistic) with less vertical movement. • Breaststroke under water; option to collect a sinker	• Being aware of the feeling of lengthening through trunk during glide phase.	
Setting goals (5 mins)	• Swimmers set a target to swim without stopping (e.g., one or two lengths)	• This is a personal journey and progress will vary from swimmer to swimmer, make sure everyone feels that they recognise personal achievements • Remind swimmers of key areas to think about with their stroke during this challenge • Examples of challenge; pyramid swim 1 length, 2 lengths, 3 lengths, 2 lengths and 1 length. • Remind swimmers about breathing during challenge and taking time to recover	
Cool down and exit (4 mins)	Floating with woggles to relax and stretches		
Session debrief and tools to help the participant become a lifelong swimmer (5 mins)	• What to expect • Teaching points • Positive feedback		

	• What to work on this week? • Reflection **Tool 6:** Review action plan and goals and signpost to possible sessions they might want to join in local pool, including adult only sessions. Information about outdoor swimming sessions (optional) with further information about safety.		

Appendix Q: Joint Display Tables for Meta Inference Chapter

Programme set up **COM-B: Physical and social opportunity** **BCW Intervention function: Enablement**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**
Length of session				
The length of the swimming session would depend on the individual, but the average time offered would be 30 minutes (93.33%)		**Theme: How swimming looks for me; COM-B Physical and psychological capability, physical and social opportunity** *'25 minutes to an hour.' (S7 Outdoor swimmer)* *'You don't have a choice! Yes, it is an hour session. Yes, the one in the Lido you are allowed in 5 minutes before the session. Yes, it is usually an hour, 40 minutes. In the class we are doing an hour session as well.' (S5 Pool and outdoor swimmer)*	**Post-programme questionnaire:** 93% of participants agreed that the sessions were the correct length **Theme: Delivery of programme, Subtheme: Set up of programme** 'When we overran, I started to feel the pain' 'We had up to an hour which is better because you then have an option to do more if you feel like you could. My minimum time was about 45 minutes but most session I used the whole hour' 'If the pool had been warmer, I do believe I could have increased the time in the pool' 'I think if it was advertised as a longer session, it could put	**Complimentary** In future trials the programme would start at 30 minutes and run for no more than one hour. A wide range of times had been suggested in study two and three, the findings from study four provided clearer guidance. **COM-B Physical opportunity** **BCW Intervention function Enablement**

			people off, especially if they were anxious about being in the water.'	
Frequency and number of sessions				
The frequency of the swimming session would depend on the individual, but the average frequency offered would be once to twice a week for three weeks. (100%)	**Barrier:** 47.5% agreed that they would hard to find the time to go swimming during the week; **COM-B Physical opportunity**	**Theme: How swimming looks for me; COM-B Physical and psychological capability, physical and social opportunity** *'3 sessions a week.' (S4 Pool and outdoor swimmer)* *'Twice a week, That fits in with work and everything else.' (S8 Pool swimmer)*	**Post-programme questionnaire:** 60% of participants agreed that 6 sessions was the right number for someone with back pain **Theme: Delivery of programme, Subtheme: Set up of programme** 'I think this is pitched exactly right' 'Additional lessons would have benefitted me more I believe' 'I believe 6 session is enough if you already know how to swim.'	**Divergence** In future trials the programme would offer more sessions for the less able swimmers but continue with sessions twice a week. It takes time for people to gain confidence swimming, more sessions could be offered to less able swimmers, however it was also acknowledged that many people find it hard to find the time to go swimming so support and behaviour change techniques may be required. **COM-B Physical opportunity** **BCW Intervention function Enablement**
Number in session				
The number in the sessions would be dependent on			**Post-programme questionnaire:** 100% of	**Convergence**

several factors but the average number in the session would be five people (73.33%)			participants agreed that five people was the right number for this programme **Theme: Delivery of programme, Subtheme: Set up of programme** 'I think anymore it would have lost the ability to be so individualised and supportive.' 'I think taking in the size of the pool and that people needed quite a bit of support this was a good mix. Probably could have had maximum of 7.' 'It dropped to 4 people, and it did feel like there was more support.'	The programme would be delivered to an average of five people. No changes were required for the number in the session. **COM-B Social opportunity** **BCW Intervention function Enablement**
Time of session				
The swimming sessions will be offered at different times during the day, except for early morning and late evening	**Preferences** 34% of participants would prefer to swim between 9-12pm and 21.1% would prefer 5-7pm	**Theme: How swimming looks for me; COM-B Physical and psychological capability, physical and social opportunity** *'I like swimming in the afternoon, I hate doing any exercise in the morning.' (S6 Pool and outdoor swimmer)* *'If I am swimming in the morning, I do need to stretch*	**Feasibility data:** 44% of participants invited to take part, consented for the study. Randomisation was not possible due to limited pool times. Reasons for not being able to make pool times included work and childcare responsibilities 41% of participants attended all 6 sessions. Reasons for not attending all sessions	**Complimentary** In future trials a greater range of times could be offered for people to allow inclusion of people who work and those with caring responsibilities. It would be difficult to find a time which suited all, offering a range of times would be the best option.

		before I go in. It used to be that I couldn't really swim properly, I couldn't do tumbles in the morning because I couldn't get round.' (S3 Pool swimmer)	included childcare and transport issues.	**COM-B Physical opportunity** **BCW Intervention function Enablement**

Pre-programme information **COM-B Physical and psychological capability and reflective motivation** **Intervention function: Enablement**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**
General health				
General health questions (100%) Heart condition or chest pain when exercise Blood clots, stroke, blood thinners, blood clotting disorder Hypertension or aneurysm Respiratory condition or short of breath on exertion, Issues with skin such as wounds, fragile skin, sensitive to chlorine Diabetes Dizzy spells, poor balance, fits, seizures of fainting	The most common adverse reaction mentioned was ear problems (n=4), followed by nose and sinus problems (n=3), two participants mentioned eye issues or concerns about eyes and two participants mentioned two conditions affecting the foot associated with swimming: verruca and toenail fungus. One participant mentioned that freestyle and backstroke tends to cause shoulder pain and another	**Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability** *'I suffer with depression.' (S9 Outdoor swimmer)* **Subtheme: How I manage my back pain; COM-B Psychological capability** *'So, I take Nortriptyline at night. I have got co-codamol.' (S6 Pool and outdoor swimmer)*	**Pre-programme health questionnaire:** All participants completed the pre-programme health questionnaire. The participants suffered a range of comorbidities including asthma, diabetes, fibromyalgia, heart conditions, mild hypertension, and mental health conditions. 31.8% of participants had to bring an asthma pump. 18.2% had to use a walking aid to get to the pool	**Convergence** No additional questions were required, sufficient information was collected before the programme to ensure the safety of the participants. People with LBP seeking rehabilitation should complete this health questionnaire prior to starting the swimming programme. **COM-B: Physical and psychological capability**

Operation, radiotherapy, or chemotherapy in last 3-months Bladder or bowel disturbances Are they already doing regular exercise or activities where they are physically active Current weight and height Do they suffer from fatigue Visual or hearing impairment Medication on poolside Do they use a walking aid, do they need this on poolside? Worried about falling or slipping, what can we do to help? If the swimming teacher or coach is unsure that the person is safe to start swimming, they could consult their GP or Physiotherapist **COM-B: Physical and psychological capability**	participant mentioned suffering a back spasm whilst swimming. **Barrier:** 43.9% agreed that they were worried about falling or slipping in the pool area or changing rooms; **COM-B Psychological capability** **Barrier:** 32.1% agreed that they would struggle getting changed due to their back pain; **COM-B Physical capability** **Barrier:** 19.5% agreed that they would find it hard to go swimming if they could not park close to the pool; **COM-B Physical capability** **Barrier:** 12.2% agreed that they would find it difficult to get from the changing room to the pool; **COM-B Physical capability**	**Subtheme: My barriers to swimming and how I overcome them; COM-B Physical and psychological capability** *'I am not a massive fan of swimming pools and I always just get a really sore throat after swimming in a swimming pool, you know that kind of heavy chlorine. I always felt intimidated but super-fast swimmers, you know the lanes, and the tumble turns. I was in the slower lane, so I think that is another reason why I turned to the open water because it seemed like a lot less stress going there.' (S10 Outdoor swimmer)*	**Safety data:** There were ten incidents recorded during the study. Developed cold: 2 Reaction to COVID-19 booster: 2 Pericarditis: 1 Flare up of sciatica: 1 Slip (day before session): 1 Hypertension: 1 Eye issues related to goggles: 1	**BCW Intervention function Enablement**
Back pain				
Questions about back pain (93.33%)	Median number of years with back pain 10.5 years	**Theme: My back pain journey**	**Pre-programme back pain questionnaire:** All participants completed the pre-programme back pain	**Convergence** No additional questions were required, sufficient information was collected

Diagnosis / cause of back pain? Further information about your back pain; how long have you had it, location of pain, type of pain and intensity. What makes your back pain better and what makes it worse? How easy is it to provoke or increase your back pain (irritability), do you get frequent flare ups? How mobile is your back? Which movements are restricted (back, legs and arms)? Do they have a foot drop of weakness? Does their back pain impact their mental health? What have you tried already; did it help?	**Barrier:** 31.3% agreed that they were worried that swimming would make their LBP worse; **COM-B Psychological capability** **Barrier:** 21.0% agreed that they found that their LBP was worse after swimming; **COM-B Physical capability** **Barrier:** 14.8% agreed that they found that their LBP was worse while swimming; **COM-B Physical capability** **Enabler:** 50.6% agreed that they believe that swimming is good for their back, and this would encourage them to swim: **COM-B Reflective motivation** **Enabler:** 38.3% agreed that experiencing less LBP in the pool would encourage them to swim; **COM-B Physical capability** **Enabler:** 23.5% agreed finding that swimming eased their LBP would	**Subtheme: Understanding my back pain; COM-B Psychological capability** *'And they just said that I have got arthritis in my SI joints.' (S13 Outdoor swimmer)* **Subtheme: How my back pain started; COM-B Physical and psychological capability** *'Historically I have had back issues since about 21, on and off.' (S2 Pool swimmer)* **Subtheme: More than just back pain; COM-B Physical capability** *'I am not sure that I have back pain so much as I have discomfort and lack of mobility in my lower back which sometimes manifests as pain if I overdo it... So, most of the time my back is just grumpy.' (S1 Outdoor swimmer)* **Subtheme: How I manage my back pain; COM-B Psychological capability**	questionnaire. Participants had a wide range of diagnosis including degenerative LBP, history of vertebral fractures, scoliosis, and sciatica **Outcome measures:** The Oswestry LBP disability index scores ranged between 18-86 at the start of the programme. Pain self-efficacy scores ranged between 0 and 50 at the start of the programme. **Observational data:** The data from the questionnaire helped plan the sessions, no further data was required.	before the programme to ensure the safety of the participants. People with LBP seeking rehabilitation should complete this back pain questionnaire prior to starting the swimming programme. **COM-B: Physical and psychological capability and reflective motivation** **BCW Intervention function Enablement**

What did your health professional recommend? Have you received any advice about being cautious about certain activities? Do they have low bone density? Are you someone who tends to avoid or push too hard with exercise? How is your back after exercise? What are your aims and goals attending this swimming programme, e.g., to reduce pain, improve fitness, manage a healthy weight?	encourage them to swim; **COM-B Physical capability**	*'Yes, I occasionally take painkillers if I am trying to sleep, and it is painful; that is only if it is really bad. I try not to take too much of that just because it would have less of an impact.' (S11 pool swimmer)* **Subtheme: My swimming journey; COM-B Physical and psychological capability and physical and social opportunity** *'When I was with my physio with the NHS, they told me that swimming might be good for my back not only that I can do it, but it might be good for my back, so I was actually recommended it.' (S11 Pool swimmer)*		
Swimming ability and experience				
Swimming ability and experience (100%) *(One length of a pool is usually 25 metres)* Can you swim aided?	52.4% were able to swim 50m or more 25.6% had been swimming in the last month **Barrier:** 31.7% agreed that not swimming well was a barrier to swimming; **COM-B Physical capability**	**Theme: Learning to swim with back pain** **Subtheme: My swimming journey; COM-B Physical and psychological capability and physical and social opportunity** *'I am not really a very strong confident swimmer. For me*	**Pre-programme questionnaire:** All participants completed the pre-programme swimming ability questionnaire Before completing the programme 35% could swim 1 length, 44% could swim front crawl, 63% could swim	**Convergence** No additional questions were required, sufficient information was collected before the programme to ensure the safety of the participants. People with LBP seeking rehabilitation should complete this

How far could you swim without stopping? (in metres) What is your preferred stroke for your back? Can you swim front crawl? Can you swim backstroke? Can you swim breaststroke? Do you swim any other stroke? If so which stroke? Are you comfortable in deep water and can you tread water? Can you put your face in the water and breathe out? Would you normally use goggles to swim? Can you enter and exit the water without assistance? If you can't what help will you require? Can you float unaided? Do you have any phobias or worries about swimming or	**Barrier:** 29.3% agreed that it would be difficult to get in and out of the pool; **COM-B Physical capability** **Barrier:** 18.3% agreed that they have a fear of water; **COM-B Psychological capability and automatic motivation** **Barrier:** 44. %% agreed they felt uncomfortable wearing a swimming costume or trunks; **COM-B Psychological capability and automatic motivation** **Barrier:** 23.5% agreed that they found the swimming pool too cold; **COM-B Physical opportunity**	*to get in the water was a feat by itself, I wouldn't get my hair wet, and I wasn't really keen on going out of the water.' (S9 Outdoor swimmer)* **Theme: Learning to swim with back pain; COM-B Physical and psychological capability and physical and social opportunity** *'I have only just started today to learn to how to put my face in the water in the swimming pool that is over a year on'. (S9 Outdoor swimmer)* **Subtheme: My barriers to swimming and how I overcome them; COM-B Physical and psychological capability** *'I still have a bit of a phobia of being claustrophobic in the water. So, I am constantly overcoming lots and lots of fears.' (S9 Outdoor swimmer)* **Theme: How swimming looks for me; COM-B Physical and psychological**	backstroke, 75% could swim breaststroke, 38% were comfortable in deep water, 56% could put their face in the water and 38% used goggles to swim **Post-programme questionnaire:** **Theme: Delivery of programme, Subtheme: Set up of programme** *'Although 6 lessons is adequate for people with back pain, for those who struggle with lack of confidence progress is slower' (S4)* **Theme: Delivery of programme, Subtheme: Heterogeneity** *'The people were of varying abilities, so the physiotherapist and swimming teacher were busy all the time' (S12)* **Observational data:** **Theme: Delivery of programme, Subtheme: Heterogeneity** *We walked around the edge of the pool and could see who was nervous and unsteady in*	swimming ability questionnaire prior to starting the swimming programme. **COM-B: Physical and psychological capability** **BCW Intervention function Enablement**

being in water, have you ever had a bad experience in water? (yes/no/ please comment) When was the last time you swam? How often have you swum in the last few months? Have you had swimming lessons as an adult? How do you feel in warmer and colder water, what temperature is best for you?		**capability Physical and social opportunity** *'At the moment I go 4 or 5 mornings, and it is about 40 minutes and Wednesday evening for an hour.' (S3 Pool swimmer)* **Subtheme: Where I swim; COM-B Physical opportunity** *'If my back is really bad, I don't really care if it is minus whatever I have swum in the sea even if it is 5 or 6 degrees, I love it.' (S9 Outdoor swimmer)*	*the water, who needed more supervision.* **Theme: Delivery of programme, Subtheme: Swimming skills** *(S2) continued to work on slowing her stroke down and breathing at the correct point and (S5) was OK with front crawl this week but prefers back stroke. (S2) legs sink and she preferred the fins and (S5) preferred the hand paddles.*	

Delivery of programme **COM-B: Physical and psychological capability** **BCW Intervention function: Enablement, education, and training**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**
A collaboration by which both a physiotherapist and swimming professional lead the sessions (93.33%)	9.8% has had swimming lessons as an adult	**Subtheme: My swimming journey; COM-B Physical and psychological capability,**	**Post-programme questionnaire:**	**Convergence** This collaboration would be used in future delivery of the swimming programme.

	Barrier: 31.3% agreed that they were worried that swimming would make their LBP worse; **COM-B Psychological capability** **Enabler:** 78.1% agreed that they were more likely to go swimming if their health professional had advised them to swim; **COM-B Reflective motivation** **Barrier:** 21.0% agree that they found that their LBP was worse after swimming; **COM-B Physical capability** **Barrier:** 14.8% agreed that they found that their LBP was worse while swimming; **COM-B Physical capability**	**Physical and social opportunity** *'When I was with my physio with the NHS they told me that swimming might be good for my back not only that I can do it but it might be good for my back, so I was actually recommended it.' (S11 Pool swimmer)* **Subtheme: My barriers to swimming and how I overcome them; COM-B Physical and psychological capability** *'I took lessons to improve my swimming. I have never been able to front crawl or anything like that so I can do that now, I put my head under the water when I swim. I do it all correctly now. It is an achievement for me at my age.' (S8 Pool swimmer)*	**Theme: Delivery of programme, Subtheme: Professional support** *'Both of the tutors were understanding of individuals needs and gave reassurance where necessary (S4)'* *'I would like to thank the physiotherapist and the swimming teacher, thanks for getting me sort of swimming'* **Observational data:** **Theme: Delivery of programme, Subtheme: Professional support** *Enjoying class. Will book more lessons with local teacher at pool, whom she knows, to gain more confidence and control in the water (S13)*	For people with LBP the data suggests that a swimming professional and a physiotherapist provides the right skill mix to deliver swimming to people with LBP. **COM-B Physical and psychological capability** **BCW Intervention function Enablement, education, and training**

Teaching / coaching approach **COM-B: Physical and psychological capability, social opportunity** **BCW Intervention function: Training, education, and enablement**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**
An approach that takes into account the different types of back pain, that may respond to differently to different swimming strokes and programs (93.33%)		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'With the initial injury it actually made it a bit worse. I found that the position that I was in in the water when swimming on my front wasn't good. The only way that I could swim comfortably was on my back.' (S14 Pool swimmer)*	**Pre-programme back pain questionnaire:** Participants described different activities and positions that could make their LBP worse or easier. **Theme: Delivery of programme, Subtheme: Heterogeneity** *'Lifting, twisting, running, standing, or sitting for tool long, sudden jerked movements'* *'Bending, sitting down without moving for long periods, walking for longer than 30 minutes.'*	**Convergence** People with LBP in study two described different methods of swimming with LBP and changes to stroke due to LBP, the pre-programme back pain questionnaire used in study four highlighted that people with LBP have different aggravating and easing factors which could be considered when delivering the swimming programme. This approach could be taken in future trials of the swimming programme. **COM-B Physical capability** **BCW Intervention function** **Training and enablement**
An approach that focuses on swimming being used to increase levels of physical activity, making swimming fun with less focus on swimming as a form of	**Barrier:** 32.1% agreed that they don't enjoy swimming; **COM-B Automatic motivation**	**Subtheme: My goals and motivation; COM-B Reflective and automatic motivation**	**Pre-programme questionnaire:** **Theme: Enablers, Subtheme: Motivation and goal setting** Participants had different aims attending the swimming programme including	**Convergence and Divergence** The observational data recorded that the participants enjoyed the fun activities, they appeared to be less conscious about

exercise and less concern about technique (78.57%)		*'We just here for fun, we just do this for fun!' (S9 Outdoor swimmer)* *'Keeping my fitness up, keeping my stamina up, because that is something you lose quite quickly, it's knowing that if I wanted to swim 3K I could got out and swim 3K, I have got that ability to do that.' (S2 Pool swimmer)* **Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'He (the coach) has changed my head position and I wonder if that has helped with the discomfort, the pain but the fact that I can swim for longer on front crawl. And I had thought that it was just the breathing but now I am thinking about it in relation to this maybe I am physically more comfortable doing it. That the way I breathe and where my head is different, and I am less humped over.' (S3 pool swimmer)*	wanting to improve fitness and activity *'I'm hoping while in the water I'll have some relief from the pain. I'm hoping my fitness level will improve and I might lose some weight and be more active.'* **Observational data:** **Theme: Therapeutic effects, subtheme: Enjoyment** The observational data noted how much the participants enjoyed the fun activities and how they forgot about having LBP and smiled. *'We finished with diving to pick up sinkers, everyone smiled and relaxed during this activity.'* **Observational data:** **Theme: Delivery of programme, subtheme: Problem solving and adapting** The data noted that LBP could be eliminated through changing or developing swimming technique.	having LBP during these activities. Although the barriers survey found that almost a third of people didn't enjoy swimming this could be because swimming can be practised in different ways. New methods of delivery incorporating a fun element could be of value to some people with LBP. The observational data also suggested that technique was important, participants reported less or no LBP when they made improvements to their swimming technique. The qualitative data supported that technique could be important. This conflicted with the findings from study less that the programme should be delivered with less concern about technique. **COM-B Physical and social opportunity** **BCW Intervention function Enablement**

			We asked S18 whether she had any back pain in a simple glide with kick, she did not. Her body position looked good. When she added the arms and breathing her legs dropped, she had to kick more and this was due to lifting her head. We tried a catch up drill, standing breathing drill reminding her to have her ear on the water. She corrected her head position and her back was comfortable whilst swimming.	
A kinaesthetic problem-solving approach whereby participants consider how their body feels when they are swimming and make changes to their stroke based upon how they feel (93.33%)		**Subtheme: How my back feels when I swim** *'So, for my back the one that I am consciously trying to do is front crawl but only using my arms, which I do not know whether it is right or wrong, but it means that I am just lengthening in the water all the time.' (S1 outdoor swimmer)* **Subtheme: How I swim with back pain; COM-B Physical and psychological capability**	**Post-programme questionnaire:** **Theme: Delivery of programme, subtheme: Problem solving and adapting** Participants discussed how they were able to adapt their stroke to reduce LBP. *'Breaststroke did cause me pain when bringing my head up each time to breathe. We adapted it to only bringing my head up when I need to breathe which allows me to perform breaststroke with less pain.'*	**Complimentary** The data from study two and study four supports the use of a kinaesthetic and problem-solving approach to swimming. Working together the participant and instructor could problem solve how to make the swimming strokes more comfortable for LBP, this approach could be used in future delivery of the swimming programme. **COM-B Physical and psychological capability**

		'I will almost lift my lower back and drop my legs because after a while if I do get in the same position for too long and relaxed, I do tend to arch and that, it doesn't necessarily cause pain but it is just uncomfortable.' (S14 Pool swimmer)	**Post-programme questionnaire 6-months:** **Theme: Delivery of programme, subtheme: Problem solving and adapting** *'I have trouble with stamina, also my back hurts after a while so I walk sometimes between lengths (S18)'.* *'I use a "noodle" to support my shoulder and to align my body, I find it beneficial' (S19)'.* **Observational data:** **Theme: Delivery of programme, subtheme: Problem solving and adapting** The data described how participants were able to use problem solving, with or without support from the instructor to make the strokes for comfortable for LBP. *(S12) had to bend her knees and was able to problem solve how she could float.* *(S14) has a painful right shoulder with limited*	**BCW Intervention function Education, training, and enablement**

			movement, so we taught her under water recovery stroke with less rotation of body	

Session brief **COM-B: Psychological capability and reflective motivation** **BCW Intervention function: Education**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**
Explain why using swimming as a rehabilitation tool**,** the benefits, and problems with this type of approach and any guidelines. Include some discussion about not knowing which swimming stroke is best for back pain. Hopefully by the end of the class the swimmers will have developed a better understanding of what stroke(s) are best for their back. Also talk about the wider benefits of swimming such as impact on weight and mental health and how this could help in the management of their back pain (86.67%)	**Enablers:** 77.8% of participants would like to use swimming to improve their muscle strength and flexibility, 75.3% to help them maintain a healthy weight or lose weight, 72.8% to improve their fitness and general health and 70.4% to improve their mood and wellbeing; **COM-B Reflective motivation** **Barrier:** 58% of participants agreed that not being sure which stroke is best for LBP could be a barrier to swimming; **COM-B Psychological capability**		**Pre-programme back pain questionnaire:** **Theme: Enablers, Subtheme: Motivation and goal setting** Participants had different aims which they hoped to achieve by attending the swimming programme; some of these aims included the wider benefits of swimming. *'Lose weight and have more movement, hopefully make me feel better in myself'* *'I hope that swimming will increase my mobility in my back which will kickstart a more pain free life. Making me happier, more relaxed, and able to enjoy day to day life without thinking all the time that I will suffer the*	**Complimentary** This discussion could be expanded to include some of the aims highlighted in the pre-programme back pain questionnaire. The wider benefits of swimming were highlighted as strong enablers in study one and the pre-programme questionnaire also highlighted that people with LBP could use the wider benefits of swimming as motivational tools. Study one had found that over half of people with LBP agree that not being sure which stroke is beneficial for LBP could be a barrier to swimming. After the

			consequences and pain of even minor activities' **Post-programme questionnaire:** 15.4% of participants on completion of the programme reported that not being sure which stroke is a barrier to LBP could be a barrier to swimming.	programme only 15.4% reported this barrier, suggesting that further discussion of this barrier may be required. **COM-B Psychological capability and reflective motivation** **BCW Intervention function Education**
Discuss any concerns, fears, and barriers**;** in relation to back pain, swimming or being in the water (100%)	**Barrier:** 44% agreed that they felt uncomfortable wearing a swimming costume; **COM-B Psychological capability and Automatic motivation** **Barrier:** 31.3% agreed they were worried that swimming would make their LBP worse; **COM-B Psychological capability**	**Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability** *'I just have to be really careful that it doesn't go again. So, there is always that kind of fear in the back of my mind that it will happen.' (S10 Outdoor swimmer)*	**Pre-programme back pain questionnaire:** Participants had been asked whether they had received advice about being cautious with certain activities One participant had been advised to 'be cautious in general.' **Pre-programme swimming questionnaire:** Participants had been asked whether they had any fears, phobias or worries about swimming and whether they had ever had a bad experience in the water. 33.3% said yes to this question. **Comments included:** 'I am afraid of running out of breath and getting tired'	**Complimentary** It was anticipated that some people may have worries about swimming and swimming with LBP. The findings from study one that 44% of people feel uncomfortable in a swimming costume was supported by observational data in that three participants chose to wear a t-shirt and baggy shorts when learning to swim. In the future they could be advised to wear a swimming t-shirt and shorts in a swimming fabric. A third of people study four had fears, worries and phobias about swimming, these could be discussed in

			'I am not confident out of my depths' **Observational data:** **Theme: barriers, Subtheme: lack of confidence** Three participants chose to wear a t-shirt and baggy shorts when learning to swim. Heavy cotton fabric affected swimming whereas purpose made swimwear would be better. *'She had ordered a rash vest, but it was the wrong size. Her large baggy T-shirt was slowing her swimming progress.'*	the pre-programme appointment. The data from study four has added more discussion points to this section of the programme. **COM-B Psychological capability** **BCW Intervention function Education**
Discuss what to expect and what is normal during and after a swim. They might experience some discomfort, mild shortness of breath and muscle fatigue; they should alert the teacher if they experience a significant increase in back pain or they feel unwell. Discuss pacing and when they should rest /pause between activities or lengths. Discuss their expectations; what do they	**Barrier:** 31.3% agreed that they were worried that swimming would make their LBP worse; **COM-B Psychological capability** **Barrier:** 21.0% agreed that they found that their LBP was worse after swimming: **COM-B Physical capability** **Barrier:** 14.8% agreed that they found that their LBP was worse while swimming: **COM-B Physical capability**		**Observational data:** **Theme: Short-term side effects, Subthemes pain and fatigue** People reported different post exercise effects including a slight increase in pain, stiffness, and fatigue *(S4) had a slight increase in pain for 24 hours.* *(S2) was a little bit stiff on Thursday.* **Post-programme questionnaire:**	**Complimentary** The post exercise effects reported were typical for people with LBP when starting a new form of exercise. The quantitative data from study four gave an idea of what proportion of people might expect an increase in pain after swimming initially. This data could be shared with participants in future trials of the programme. In both study one and study four a

want to achieve from the session (100%)	**Enabler:** 50.6% agreed that they believe that swimming is good for their back, and this would encourage them to swim; **COM-B Reflective motivation** **Enabler:** 38.3% agreed that experiencing less LBP in the pool would encourage them to swim; **COM-B Physical capability** **Enabler:** 23.5% agreed finding that swimming eased their LBP would encourage them to swim; **COM-B Physical capability**		After the session, later that day 33.3% of participants were able to do less than they usually could and 46.7% reported that their pain was worse. **Theme: Short-term side effects, Subthemes pain and fatigue** 'I was a little stiffer that usual but still manageable' **Theme: therapeutic effects, Subtheme: Mental health and wellbeing** 'I felt more alert. Everyone I saw after the lessons said how well I looked'. **Post-programme questionnaire:** **Barrier:** 46.2% of participants reported that if their LBP was worse after swimming this could be a barrier **Barrier:** 30.8% of participants were worried that swimming would make their LBP worse	similar proportion had concerns that swimming would make their LBP worse. Pain after swimming was reported to be a barrier to swimming to 46.2% of participants in study four, compared to 21% in study one. The difference in the findings could be related to the participants in study four recently experiencing swimming, whereas in study one, only 74.4% had swum in the preceding month. **COM-B Psychological capability** **BCW Intervention function Education**
It is assumed that the following would be included prior to any swimming class;			**Observational data:** There were no concerns about this section apart from	**Complimentary** It would be worth asking participants to arrive 10

safety information, housekeeping, water temperature, depth, safety procedures, register changes in health, back pain, and wellbeing, are they well hydrated and when did they last eat. How to enter and exit water and summon help. Introduction to the type of session, session plan, which strokes, aims, objectives and the time the session will run.			it was noted that people didn't always arrive on time. **Theme: Delivery of programme; Subtheme: Set up of programme** *'People arrived at different times for first session'*	minutes early to allow for late arrivals, this would ensure everyone listened to the briefing and it did not need to be repeated. **COM-B Psychological capability** **BCW Intervention function Education**

Session debrief **COM-B: Psychological and physical capability, reflective motivation** **BCW Intervention function: Education, training, persuasion**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**
Explain how the person might feel afterwards and how to deal with it. Flare up of pain, advice / reassurance, and safety netting (100%)	**Barrier:** 31.3% agreed that they were worried that swimming would make their LBP worse; **COM-B Psychological capability** **Barrier:** 21.0% agreed that they found that their LBP		**Observational data:** **Theme: Short-term side effects, Subthemes Pain, and fatigue** People reported different post exercise effects including a slight increase in pain, stiffness, and fatigue	**Complimentary** The post exercise effects reported were typical for people with LBP when starting a new form of exercise. The quantitative data from study four gave an idea of what proportion of people might expect an

	was worse after swimming; **COM-B Physical capability**		*(S4) had a slight increase in pain for 24 hours.* *(S2) was a little bit stiff on Thursday.* **Post-programme questionnaire:** After the session, later that day 33.3% of participants were able to do less than they usually could and 46.7% reported that their pain was worse. **Theme: Short-term side effects, Subthemes Pain, and fatigue** 'I was a little stiffer that usual but still manageable' **Others reported:** 'I felt more alert. Everyone I saw after the lessons said how well I looked'. **Post-programme questionnaire:** **Barrier:** 46.2% of participants reported that if their LBP was worse after swimming this could be a barrier **Barrier:** 30.8% of participants were worried that swimming would make their LBP worse	increase in pain after swimming initially. This data could be shared with participants in future trials of the programme. In both study one and study four a similar proportion had concerns that swimming would make their LBP worse. Pain after swimming was reported to be a barrier to swimming to 46.2% of participants in study four, compared to 21% in study one. The difference in the findings could be related to the participants in study four recently experiencing swimming, whereas in study one, only 74.4% had swum in the preceding month. **COM-B Psychological capability** **BCW Intervention function Education**

Cover any teaching / coaching points that were difficult to communicate while they were in the water or as a group. What could they adjust or adapt in the next session (100%)			**Observational data:** **Theme Delivery of programme, Subtheme swimming skills** Each person had difference teaching points; they were happy these were share in the group setting. *'She needs to be reminded to kick after her push-glide as her legs drop and then she has difficulty raising her arms. She is fine once she remembers to kick, stretch her arms out and breath to the side but there are still elements of panic in her swimming.'*	**Convergence** The data from study four supported this section of the swimming programme, no changes were required. **COM-B Physical and Psychological capability** **BCW Intervention function Education and training**
Positive feedback from teacher / coach. Finish with a reflection on achievements, not problems (93.33%)			**Post-programme questionnaire:** The feedback on this aspect of the programme was positive **Theme Delivery of programme, Subtheme; Professional support** *'It was wonderful to have support and guidance.'*	**Convergence** The data from study four supported this section of the swimming programme, no changes were required. **COM-B Reflective motivation and Psychological capability** **BCW Intervention function Education and persuasion**
What to work on before the next session? Goals for the	**Enabler:** 61.7% reported that setting goals and		**Observational data:**	**Complimentary**

following week? Motivational tools they could consider? What will be covered in the next session. Dryland exercises they could try this week. Do they need any equipment next week? (100%)	making an action plan could enable them to swim more regularly.		This was easy to deliver during the sessions. **Theme: Enablers, Subtheme Motivation, and goal setting** *'We spoke about how to keep going with swimming and where to swim.'* **Post-programme questionnaire:** **Enabler:** 57.1% reported that setting goals and making an action plan could enable them to swim more regularly.	Setting goals and making an action plan could work for some participants but as the data from study one and four suggests other motivational tools should be considered in future delivery of the programme. **COM-B Psychological capability** **BCW Intervention function Education**
Reflection on session, general feedback from swimmer. What they expected versus what they achieved during session? How it felt, was any of the session uncomfortable for their back, do they have any concerns? What went well, what did they enjoy, what was more challenging, what did they dislike? What did they find most beneficial in this session? How are they feeling physically and psychologically? Relate to key values or goals (94%)			**Pre-programme questionnaire:** **Theme: Enablers, Subtheme Motivation, and goal setting** Participants had different aims attending the swimming programme including wanting to regain confidence to swim again. *'I hope to regain my confidence to swim again and that it will help reduce my back pain.'* **Post-programme questionnaire:**	**Convergence** The data from study four supported this section of the swimming programme, no changes were required. The feedback from the post-programme questionnaire aligned with the aims discussed in the pre-programme questionnaire. **COM-B Reflective motivation and psychological capability** **BCW Intervention function Education and persuasion**

			Theme Therapeutic effects, Subthemes: Confidence and mental health and wellbeing The participants enjoyed the sessions and reported a wide range of benefits including gaining confidence in swimming and positive impact both physically and mentally. *'I really enjoyed the sessions and feel that I have become more confident in the water.'* **Observational data:** **Theme: Delivery of programme, Subtheme: Peer support** *They are spoke about their goals to continue swimming, supporting each other.*	

Warm up **COM-B: Physical and psychological capability** **BCW Intervention function: Education and training**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**

Awareness activities including getting used to the sensation of the water and the feeling of weightlessness, how does this impact on movement and breathing. Feeling the sensation of lengthening through their trunk when moving through water. Bringing an awareness to their breathing using techniques and exercises. Acclimatisation to the water temperature, if the session is in different settings feeling what water temperature is best for their back (93.33%)			**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** The awareness activities were useful, allowing a transition from being on land to exercising in the water. This usually involved integration of awareness into one of the activities below. *They were quite confident walking around the pool. Good to get sense of depths of pool and slope.*	**Convergence** The awareness activities would be included in all sections of the program, not just the warmup. They were useful for the transition from land to water. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Relaxation, floating and sculling (93.33%) Also see core aquatic skills section			**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** Sculling was used most frequently as it enabled participants to warm up. It was too cold to go straight into floating and relaxation *The whole group started with a sculling sitting on woggle warm up - this enabled them to warm up their shoulder*	**Convergence and Divergence** The sculling would be used in future delivery of the warmup section of the programme but not the relaxation and floating, this would be moved to core aquatic skills and cooldown. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**

			muscles cuff and improve their balance in the water. *We started with sitting on the noodles and passing the ball around as a whole group.* **Theme: barriers, Subtheme: Pool temperature** *(S12) got very cold. I will bring a wetsuit. The water temp is 27 due to boiler issues.*	
Stretches in the water for back, neck, arms, and legs, including usual physio stretches. Finding out whether it is better for back to do stretches when they first get in pool or after some low intensity swimming (80%)		**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** *'I do, do a general one, it is not particularly organised one, but it is just to loosen off because I tend to swim first thing in the morning. I do find when I get up my back has obviously been in one position and it just needs a bit of loosening off before I get in, because otherwise I find the first 200m quite uncomfortable so I will do some general loosening off before I get in but nothing specific.' (S14 Pool swimmer)*	**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills and Equipment** The stretches were carried out on the side with theraband or in the water bringing knees up to chest *Due to shoulder issues they all warmed up with theraband, they can keep the theraband. We discussed the value of a warm up.*	**Convergence** Dynamic stretches were useful during the warmup and would be included in future delivery of the programme. **COM-B Physical capability** **BCW Intervention function Education and training**
Start with **easy / low intensity swimming** (front crawl and backstroke),		**Subtheme: My training regime; COM-B Physical and psychological capability,**	**Observational data:**	**Complimentary** The data from study two and four suggests that this

gradually increasing intensity. Finding out whether it is better for them to warm up alternating strokes or with just one stroke (81%)		**Physical and social opportunity** *'I do 400m just relaxed, no stress freestyle just stretching out slowly and then I will do another 400 and I will throw in a breaststroke length. So, every 4th length will be breaststroke, just so I can start stretching. Long stretching breaststroke just to start, opening up, just stretching all the bits that need to be stretched.' (S2 Pool swimmer)*	**Theme: Delivery of programme, Subtheme: Aquatic skills** This warmup was used less frequently as they were still learning, the more able swimmers were able to use this warm up *We started with a slow choice swim warm up.*	could be a suitable warmup for more able swimmers. **COM-B Physical capability** **BCW Intervention function Education and training**
Walking in the water, different directions, different speeds, with or without floatation aids, walking while doing sculling movements with arms (94%)			**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** The walking was the most popular warm up for the groups. People with all levels of swimming abilities could use this warm up *We ended up walking around in a circle round the edge of the pool holding onto the woggles, this enabled them to understand the depth of the pool at the deep end and got them moving. We could then see who was nervous*	**Convergence** The observational data suggests that this would be a useful warmup for all swimmers. **COM-B Physical capability** **BCW Intervention function Education and training**

			and unsteady in the water and they needed more supervision.	

Cool down **COM-B: Physical and psychological capability, Social opportunity, and Automatic motivation** **BCW Intervention function: Education and training**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**
Gentle stretches in the water, specific stretches advised by physiotherapist. Does the movement feel easier compared to the start of the session? (88%)			**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** The lumbar flexion stretch was very helpful, it was also used during the session. *S9 tried OEB at the end and found that this was comfortable and stretched.*	**Convergence** The observational data supported using this exercise during the cooldown. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Sculling on back with or without breaststroke kick and just kicking. Breathing, relaxation, floating on back, meditation type breathing exercises (93.33%)			**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** Old English backstroke with sculling arms was a suitable cooldown for most of the	**Convergence** The observational data supported using this exercise during the cooldown.

			participants. Floating with woggles enabled the participants to relax in the water. *The more able swimmers spent time working on old English back stroke in various forms and traditional backstroke.* *S5 requested floating on the woggles for the cool down. S2 required 2 woggles as her feet sank.*	**COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Easy / low intensity swimming. Changing the stroke from the main set, e.g., if swam on front then would cool down on back (86.67%)			**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** When learning it was found that the intensity of swimming was low. It was useful to change strokes *We finished with backstroke glide and sculling arms and legs.*	**Complimentary** The observational data supported the use of changing strokes but not reducing the intensity unless the intensity was high in the session. **COM-B Physical capability** **BCW Intervention function Education and training**
Walking in water and gentle movements with a fun element (94%)			**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** Walking was not used in this section of the programme but movements with a fun element were popular and	**Convergence and divergence** The observational data supported using movements with a fun element. Walking would be used in the warmup.

			enabled the participants to relax and smile. *The more able swimmers finished with under water swimming, S2 can manage this but S5 floats too much. The had another go with the sinkers which they enjoyed.*	**COM-B Social opportunity and Automatic motivation** **BCW Intervention function Education and training**

Core aquatic skills **COM-B: Physical and psychological capability** **BCW Intervention function: Education and training**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**
Learning how to cope with a painful episode when swimming, being able to indicate when they need support. Being able to get to the side or shallow water independently (100%)	**Barrier:** 31.3% agreed that they found that they were worried that swimming will make their back pain worse. **COM-B Psychological capability**	**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'I kind of lie down on the water and float on the water, my body floats quite well.' (S5 Pool and outdoor swimmer)*	**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** This was a valuable skill to learn during the programme *Everyone seemed happy that they could deal with this problem*	**Convergence** This aquatic skill would be included in the programme, it is best to be prepared so that it is not seen to be a reason for avoiding swimming. Flare ups can occur at any time. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Water safety**,** how to enter and exit the water, learning to make adjustments, trying	**Barrier:** 29.3% agreed that they would find it difficult to get in and out of the	**Subtheme: Where I swim; COM-B Physical opportunity**	**Observational data:**	**Convergence** This aquatic skill would be included in the programme,

different methods to reduce discomfort or accommodate for back pain, loss of strength and mobility. This could include using steps, sliding in, using ramps or hoists (100%)	pool; **COM-B Physical capability**	*'There's like a fisherman's jetty and there is a bank and over time there are 2 sort of steps that have been worn down. You just step down and there are metal cases filled with stones and you can just kind of tentatively get down and there is a place to hold onto and then you are in.' (S10 Outdoor swimmer)*	**Theme: Delivery of programme, Subtheme: Aquatic skills** The options in this pool were steps or a ladder, the access from the changing room was steps or a ramp. *Entering pool - all Ok except S13 - She had to go down the ramp from changing room but could get in pool using bar safely*	Study one found that almost a third of participants would find it difficult to get in and out of the pool. Study two highlighted that there are different considerations in open water regarding access to water. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Learning to change position in water (e.g., from front to back), using the core muscles during these transitions and relaxing the spine to allow it to move freely. Being aware how this feels different in the water when compared to being on dryland. Practicing different ways of turning at end of length, finding out which feels more comfortable. If nerve damage affecting one leg, then look at how could modify push off wall (100%)		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'Most people push off; they might not have both feet aligned on the wall and push because they don't have that luxury. Well for me that would cause a lot of pain because you push off perhaps with one leg being slightly out of alignment from the other.' (S7 Outdoor swimmer)*	**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** Learning this skill enabled the participants to put less strain on their back when they changed position in the water. *S9 initially used her arms to stand up, but then we practised bring her knees up and this was much less of a struggle, she could do this both from prone and supine.* *S21 found it hard to plant feet back on floor from supine and*	**Convergence** The data from study two had highlighted that changing position could be difficult for some people with LBP. The observational data supported using this skill in future programmes to reduce chance of flare ups and improve safety in the water. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**

			prone, he said he has had less sensation in his legs since the fall 2 years ago. *We demonstrated a smooth slow turn, they all managed this and felt it was useful to practise.*	
Trying hybrid strokes if standard strokes do not agree with them, looking at different combinations of arm propulsion, kick, and body positions, which combination feels best for them. This could be considered if issues with other joints, such as shoulders or knees (100%)		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'Double armed backstroke, old English backstroke. If I am really stiff then I will do that as well, not just normal backstroke. Like when I do my stand up double armed stretch, I can get them back as far as I possibly can. And the weight of your legs sort of almost helps the stretch on your back. So, a big kick ad a massive glide and try and get those back as far as I can. For however many lengths it takes'. (S3 Pool swimmer)*	**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills and swimming skills** Hybrid strokes enabled swimmers to adapt swimming for joint problems, not just LBP. *S9 tried old English backstroke at the end and found that this was comfortable* *S21 and S19 did not have enough flexibility so will do sculling arms. They all made progress with backstroke.*	**Complimentary** Hybrid strokes trialled in study four included Old English backstroke, sculling on back with breaststroke arms and front crawl with underwater recovery. Only Old English backstroke had been discussed in study two. These other two strokes could be included in future programmes. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Learning to float**,** trying different head, body, arm, and leg positions in water, feeling which ones are more comfortable for their back. Learning to relax while			**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** Floating was best learned after gliding; woggles	**Complimentary** Study four found that floating was best learned after learning to glide and woggles were useful with the less able swimmers.

floating in the water. Learning how to stretch whilst floating. Using floating to increase core strength. Using floating to deal with panic in the water or if experiencing cramp. Using equipment to support body whilst floating (100%)			supported the less able swimmers. *S3 was able to float and scull and also able to do a mushroom float.* *S9 wasn't sure she could float and initially her legs were sinking when she was supine, I encouraged her to lift her hips and legs and she was able to float.*	There was no data from study one or two on this topic. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Developing a feel for the water with hands through sculling, feeling how core muscles are recruited with this movement, trying sculling in different positions (on back, on front and vertical) (93.33%)		**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** *'I do some sculling, I'll just do a couple of lengths of just travelling stretches so sculling with my arms above my head.' (S12 Pool swimmer)*	**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** Sculling was practised to improve the feel for the water, hand paddles were used to enhance this feeling during some exercises, sculling was integrated into the warm up, when treading water and when using hybrid strokes. *We practised sculling in standing and then sat on a woggle, discussing feel for the water and core muscles.* *All three could float on their backs and scull* *S9 practised treading water again, we tried the hand*	**Complimentary** Some of the swimmers in study two discussed how they used sculling during their swims. It could be used to improve the feel for the water, stretch and improve core muscle strength. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**

			paddles to increase the feel for the water with the sculling.	
Learning how to tread water and jog in deep water with a float, trying different arm and leg movements, feeling which movements are more comfortable for back (93.33%)			**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** Aqua jogging was an option for the older swimmers and those with neck and shoulder complaints. Learning to tread water was an important safety skill. *The more able swimmers worked on treading water and talking about outdoor swimming and safety. Tried eggbeater kick, they managed this well and also reviewed sculling of hands.*	**Complimentary** Study four found that aqua jogging was an option for the older swimmers and those with neck and shoulder complaints. There was no data from study one or two on this topic. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Breathing exercises with head out and in the water, mindful breathing, compare breathing out through mouth and nose, compare different speeds of inhalation and exhalation. Develop an awareness of how body feels with different styles of breathing, discover which variation feels more		**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** **Subtheme My barriers to swimming and how I overcome them; COM-B Physical and psychological capability**	**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** Participants had different levels of confidence with aquatic breathing, the nose clip helped some progress quicker. *S12 and S14 tried aquatic breathing with and without*	**Complimentary** Aquatic breathing is a core skill for all swimmers. Data from study two and four supported the teaching of this skill in future delivery of the programme, the provision of a nose clip could be included if they struggle with this skill.

comfortable for back and breathing. Discuss concerns about putting face in water such as feeling claustrophobic. Learning how to fit and wear goggles so able to relax when breathing in water. Learn how breathing exercises can be used to manage anxiety, pain, and focus on the present moment (86.67%)		*'A friend told me I should be breathing every three not every two so that you are not permanently breathing one side, so I am breathing every three but in order to do that I had to get rid of my legs.' (S1 Outdoor swimmer)* *'I have only just started today to learn to how to put my face in the water in the swimming pool that is over a year on.' (S9 Outdoor swimmer)* *'Now I breathe every four, I was just breathing when I needed to breathe and then it was really 'gaspy'. So, Graham said to me that you don't need to hold the breath. As soon as you breathe in just let it go straight away.' (S3 Pool swimmer)* *'I do 3,5,7,9 breathing ladders.' (S12 Pool swimmer)*	*the nose clip, they were comfortable putting their face in the water. S13 practise dipping down into water to blow bubbles out nose and mouth, with and without the nose clip.* **Pre-programme questionnaire and Observational data:** Before starting the programme 56% could put their face in water and 38% used goggles to swim, on completion of the programme 100% could put their face in water and use goggles to swim.	**COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Learning to glide and move in a streamline way, trying different head, body, arm, and leg positions in the water, feeling which ones are more comfortable for back			**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** Gliding on the front and back was helpful, the swimmers	**Complimentary** In study four this skill was invaluable in teaching a streamline position in the water. There was no data

and which improve the efficiency of the movement through the water (93.33%)			struggled to glide on their side. *They hadn't tried gliding before; they were surprised that they could travel the whole width without kicking. They found gliding on their side harder to master but easier on their back.* *S6 said she was 'rubbish' at front crawl because she kept her head up so we progressed from a push glide with her face in the water and she attempted to breath to the side*	from study one or two on this topic. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**
Awareness exercise**:** do they feel more confident moving in the water than on land, can they do more in the water, do they have less fear of movement, does their back feel different in the water, do their muscles feel more relaxed in the water, do they feel that the water is providing support for their back? Trying different movements that they struggle with on land in the water, if this movement feels		**Subtheme: My feelings about swimming; COM-B Automatic motivation** *'I was saying to someone the other day, you know you are literally having to stay alive aren't you and focusing on just that process of staying afloat. I think with my back pain it's always in the back of my mind even if there isn't any, I am pre-empting almost, the more I do it the less I have been kind of*	**Observational data:** **Theme: Delivery of programme, Subtheme: Aquatic skills** Awareness exercises were integrated during the swimming programme. *I reminded S14 that she can just relax in the water.*	**Convergence** The findings from study two had suggested that being in the present moment when swimming could be valuable when learning to swim with back pain. This was also found to be important in study four, it could be included in any section of the programme. **COM-B Physical and psychological capability**

easier, practising it in water. Learning to be in the present moment during swim (87.5%)		*worrying about it.' (S10 outdoor swimmer)*		**BCW Intervention function Education and training**

Swimming strokes **COM-B: Physical and psychological capability** **BCW Intervention functions: Education and training**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**
		Front crawl		
Practising different **head positions** whilst swimming, taking care not to swim with head too high in the water, feeling how different positions affect their neck, body position and back (100%) Learning how to adopt a more **streamline position** in the water for their body so that less effort required to swim, adding a pull buoy or flotation trunks if required so swimming close to surface (86.67%)		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'So, I tend to concentrate on front crawl, that's the one I feel most comfortable with' (S2 Pool swimmer)*	**6-month post programme questionnaire:** 87% were able to swim front crawl Ability to swim front crawl further was limited by back pain in 60% of participants. **Observational data:** **Theme: Delivery of programme, Subthemes: Swimming skills, aquatic skills, Equipment and Problem solving and adapting swimming** All the suggested swimming exercise for front crawl were trialled during the swimming	**Complimentary** The findings from study two had suggested that most people with LBP would be able to tolerate swimming front crawl. 6-months after the programme 87% of people were able to swim front crawl to varying degrees. All of the suggested front crawl teaching points and exercises could be included in future programmes, they were tolerated well and supported the learning and development of this stroke. A push into a glide helped participants achieve a more

Improving rotation of the trunk so that the whole body rotates, learning to breathe both sides if possible. Learning to move smoothly through water using this rotation. Drills to enhance rotation could include 6 kicks and roll and a single-arm drill. Do they feel better using front crawl to improve the rotation in spine or is it more comfortable to rotate the whole body? (86.67%) **Being mindful to exhale** in the water and to inhale the normal amount of air, not hyperventilate. Practising different intervals when taking a breath. Compare breathing through mouth and nose. Practise different speeds of inhalation and exhalation. Compare different head positions when taking breath to the side. Discover which variation feels more comfortable for back and for breathing (100%)			programme. Some swimmers had to adapt front crawl if they had restricted shoulder movement or pain to an under-water recovery. Nose clips helped with the breathing control. A push into a glide helped them achieve a more streamline position. They found that practising widths initially was helpful so that they did not have to add the breathing. A good technique seemed to reduce LBP during swimming. Some participants found using the hand paddles and pull buoy helpful during drills. *S2 worked on breathing timing and head position when breathing ie not looking ahead, which we rehearsed in standing first and S looked at ways to adapt frontcrawl arms when shoulder restricted including underwater doggy paddle. Both were rotating body in water* *From a push glide he managed 5 front crawl*	streamline position. They found that practising widths initially was helpful so that they did not have to add the breathing. A good technique seemed to reduce LBP during swimming, this was also suggested by the participants in study two. Some participants found using the hand paddles and pull buoy helpful during drills. Bothe study two and four found methods of adapting front crawl, although different methods were discussed in study two than were practised during study four, possibly due to the difference in swimming ability. **COM-B Physical and psychological capability** **BCW Education and training**

If unable to use legs whilst swimming (e.g. due to nerve damage) finding ways to swim and keep in a streamline position either with floats, using core or increasing speed. If nerve damage only affecting one leg, find out whether better for back to use just one leg or no legs (93.33%) Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back (**a problem-solving approach**) (93.33%)			*strokes and then took one breath to the side.* *The more able swimmers discussed a good body position from a push-glide with gentle kicking from the hip.* *S2 continued to work on slowing her stroke down and breathing at the correct point* *S9 worked on breathing to the side, as she was lifting her head forwards. She focused on just one side and then just the other side.* *S10 was bending her right knee during the kick, S7 was breathing at the front and not using goggles, and all were using a straight arm recovery. We tried some recovery drills to encourage bending the elbow such as zip and touch shoulder, it improved, and I discussed how this is easier for their shoulder. We worked on just kick trying to get the kick from the hip.*	

			S17 worked on timing breath to arms, her back felt better only breathing every 3rd stroke, not every stroke cycle.	
Backstroke				
Learning to swim backstroke with **head looking up**, not down the pool to relax neck muscles and to reduce sinking of legs, being aware how head position changes low back position whilst swimming. Learning to follow ceiling or if outside shore or bank to reduce disorientation in this position and to keep swimming course straight (80%) **Learning how to improve rotation** of body during backstroke. Being aware how this could increase the feeling of lengthening in spine and improve the efficiency of the arm pull. Do they feel better using back stroke to improve the rotation in the spine or is it more comfortable to rotate the whole body? Using this rotation to move smoothly through water. Drills: single		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B Physical and psychological capability** *'With the initial injury it actually made it a bit worse. I found that the position that I was in in the water when swimming on my front wasn't good. The only way that I could swim comfortably was on my back.' (S14 Pool swimmer)* **Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability** *If anything, I have improved, rather than steer away, the backstroke is just a*	**6-month post programme questionnaire:** 67% were able to swim backstroke Ability to swim backstroke further was limited by back pain in 50% of participants. **Observational data:** **Theme: Delivery of programme, Subthemes: Swimming skills, aquatic skills, Equipment and Problem solving and adapting swimming** All the suggested swimming exercise for backstroke were trialled during the swimming programme, except for the flags, instead the ceiling tiles were counted. Some swimmers had to adapt backstroke if they had restricted shoulder movement or pain to sculling arms. Nose clips helped with the breathing control. A push	**Complimentary** The findings from study two had suggested that most people with LBP would be able to tolerate swimming backstroke. 6-months after the programme 67% of people were able to swim backstroke to varying degrees; more support maybe required during the programme for this stroke. All of the suggested backstroke teaching points and exercises could be included in future programmes, they were tolerated well and supported the learning and development of this stroke. The most common adaptation was the arm stroke, due to restricted shoulder movement, this was not discussed during study two, presumably due to them being a younger

arm pull, not over kicking, kick only to keep legs in correct position in water (75%) **Being mindful to exhale** through nose so water does not enter nose whilst on back and to inhale the normal amount of air, not hyperventilate. Practising different intervals when taking breath with stroke. Practise different speeds of inhalation and exhalation. Discover which variation feels more comfortable for back and for breathing (86.67%) **Learning how to use the flags** when swimming backstroke so able to judge how close to the end and therefore allowing the swimmer to stay on their back and relax when swimming this stroke (86.67%) **Learning alternative ways to swim on the back** such as old English backstroke		*confidence thing, but I could do it.' (S8 Pool swimmer)*	into a glide helped them achieve a more streamline position. They found that practising widths initially was helpful. A good technique seemed to reduce LBP during swimming. *The more able swimmers discussed a good body position from a backstroke glide and keeping the head still and looking at a line in the ceiling with just the shoulders rotating and gentle kicking from the hip. S5 was very confident on her back and felt comfortable.* *The more able swimmers practised knowing when to stop and again rotating and bending the elbow during the pull. They mentioned that the water was going up their nose during backstroke, so we tried the nose clips which worked really well.* *S6 wanted to try backstroke and proceeded to swim a width very confidently! We discussed pushing off the wall*	population with less comorbidities. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**

(breaststroke kick and double arm pull) or sculling with breaststroke or flutter kick, being aware how back feels with different versions of stroke (86.67%) Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back (**a problem-solving approach**) (93.33%)			*and keeping a good body position in the water which she achieved very well.* *All three agreed that front crawl and backstroke caused no pain* *S9 worked on backstroke, initially trying a glide, this was better if she was hugging a float and then added the kick. She was quickly able to add her arms and was a natural, rotating her body and with a bent arm pull.* *S9 is able to manage standard backstroke, she is better at the start after the glide but slowly her legs sink. I spoke about using back stroke to help recover her breathing between front crawl.*	
Breaststroke				
Learning flatter breaststroke with slower stroke turnover (less ballistic), longer glide and wedge kick (the older style of swimming breaststroke).		**Subtheme: How I swim with back pain; COM-B Physical and psychological capability** **Subtheme: How my back feels when I swim; COM-B**	**6-month post programme questionnaire:** 87% were able to swim breaststroke	**Complimentary** The findings from study two had suggested that some people with LBP would be able to tolerate swimming breaststroke. 6-months

Being aware of the feeling of lengthening through trunk during glide phase (81%) **Practising different head positions** during the stroke cycle, allowing the head to dip to relax neck muscles when face in the water, feeling how different positions effect their neck and back (94%) Trying breaststroke with **more and less undulation**. Do they feel better using more undulation to mobilise the lumbar spine or less undulation? (81.25%) **Being mindful to exhale** in the water and to inhale the normal amount of air, not hyperventilate. Practising different lengths of glide, which will affect intervals when taking a breath and different speeds with stroke transitions (e.g., from pull to glide). Compare breathing through mouth and nose. Practise different speeds of inhalation and exhalation.		**Physical and psychological capability** *'Breaststroke, Front crawl, that doesn't affect me but with breaststroke you have to be careful with your knee. Breaststroke is my strongest one. Front crawl I focus more on the breathing, it is the difficult one to coincide everything. Breaststroke is my main strength.' (S8 Pool swimmer)* **Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability** *'I had a couple of lessons with a teacher, near Bodium in the river, and she was teaching me a better breaststroke. So really going down into the water and up and she was saying if you are swimming above the water the whole time it is really bad for you, it will strain your back so yes, I would say that I am quite careful about really*	Ability to swim breaststroke further was limited by back pain in 60% of participants. **Observational data:** **Theme: Delivery of programme, Subthemes: Swimming skills, aquatic skills, Equipment and Problem solving and adapting swimming** All the suggested swimming exercise for breaststroke were trialled during the swimming programme. Not every swimmer tolerated breaststroke and breaststroke was best integrated with other strokes. *The more able swimmers practised sculling on back with breaststroke legs. The less able swimmers tried the old English backstroke which S3 found very comfortable and easy.* *S8 want to work on breaststroke and find out why one leg kicks differently,*	after the programme 87% of people were able to swim breaststroke. All of the suggested breaststroke teaching points and exercises could be included in future programmes, they were tolerated well and supported the learning and development of this stroke. The findings from both study two and study four suggested that developing a good technique and integrating breaststroke with other strokes would be better for someone with LBP. On person in study four found that her kick was affected by less movement in the hip due to sciatica, this would be an area to check in future studies. **COM-B Physical and psychological capability** **BCW Intervention function Education and training**

Discover which variation feels more comfortable for back and for breathing (100%) **Trying different ratios of kick and pull**, e.g., two kicks to one pull so longer period when flatter in water, feel the difference with different ratios on back (86.67%) **Learning how to do breaststroke kick on back**, with sculling arms or double arm pull (old English backstroke), feeling how this change in position affects their back. Use this position on back to improve awareness and develop breaststroke kick. Use noodle if requires support initially. Alternately stroke on front and back, if back better changing position more frequently (81%) **Experiencing swimming breaststroke under the water** for example trying the drill; 3 kicks above water, 3 kicks below the water or		*following, I have her words in my mind that I really focus on my stroke.' (S10 Outdoor swimmer)*	*due to muscle weakness. I have said that I will look at her kick next time, initially on her back.* *S10 said she previously only swam breaststroke but once she was able to push glide and breath successfully to the side, she realised that front crawl suited her better as she felt no pain in her upper back. Breaststroke appeared to aggravate her back condition.* *Her breaststroke is very vertical so we worked on the kick first, she was not dorsiflexing her ankle so had weak propulsion during the kick, we sat on a step and looked at the correct kick and then practised the kick supine.* *S9 is more relaxed about front crawl and breaststroke. We practised the leg kick and longer glide and controlled breathing.*	

breaststroke legs only under water. Being aware of feeling of weightlessness under underwater and lengthening through trunk (78.57%) Trialling different head, body, and leg positions for each swimmer, learning how to make the stroke more comfortable for their back (**a problem-solving approach**) (94%)			*S8 has great backstroke technique, she is very comfortable with this stroke. We looked again at breaststroke, her right hip is restricted due to recurrent sciatica, she had problem solved that this was causing her to do a screw kick. We checked her kick on the steps (in sitting) and her right hip has to abduct to flex, she will chat to her physio about some home stretches, and I showed her the piriformis stretch in the water.* *S11 worked on Breaststroke kick on back, timing the arms with the kick and holding the glide.*	

Strategies to enable people with CLBP to become regular swimmers on completion of the programme **COM-B: Social and physical opportunity, psychological capability, reflective motivation,** **BCW Intervention function: Enablement, education, modelling, environmental restructuring, persuasion, and training**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**
Making the swimming sessions fun, enjoyable and sociable (100%)	**Barrier:** 32.1% agreed that they don't enjoy swimming;	**Subtheme: My swimming community; COM-B Social opportunity**	**Post-programme questionnaire:** 57% of participants agreed that	**Divergence** Some people in study four enjoyed the fun and

	COM-B Automatic motivation	**Subtheme: My feelings about swimming; COM-B Automatic motivation** *'We just here for fun, we just do this for fun!' (S9 Outdoor swimmer)*	going with a friend or family member would help them continue to swim on a regular basis **Observational data:** **Theme: Therapeutic effects, Subtheme: Enjoyment** *We started with sitting on the noodles and passing the ball around as a whole group.* *S9 enjoyed trying to dive for the sinker and was laughing.*	sociable element of the programme, but not all. The activities they enjoyed the most were the ones which are normally used when teaching children to swim. They enjoyed the challenge, and it was good to see them laugh and smile. A third of people in study one didn't enjoy swimming however in study two the subtheme, my feelings about swimming suggested that for this group swimming was enjoyable and for some fun. It is likely that this strategy could enable some people with LBP but not all for some but not all. **COM-B Social opportunity** **BCW Intervention function Enablement**
Subsidised / discounted access to pool (100%)	**Barrier:** 37.8% agreed that the cost of swimming would prevent them from swimming; **COM-B Physical opportunity**		**Post-programme questionnaire:** 71% of participants agreed that if they were eligible for a discount on swimming fees then this would help them continue to swim on a regular basis.	**Complimentary** A greater proportion of participants in study four than study one agreed that cost could be a barrier to swimming. The reason for this difference could be a different population had been recruited or this study

			71% of participants agreed that the cost of swimming could stop them from going swimming. **Observational data:** **Theme: Barriers, Subtheme: Cost** *Two participants would struggle to afford to swim regularly as they were not working.*	were conducted a year apart and the financial pressures could have been greater. **COM-B Physical opportunity** **BCW Intervention function Enablement**
Information about access to local pools and cost. Information about changing facilities. Discuss about taking time to prepare to get in the water and to leave the venue. Information about outdoor swimming sessions with further information about safety (100%)	**Barrier:** 23.5% I find that the swimming pool is too cold **COM-B Physical opportunity** **Preferences** The most popular time was in the morning (9-12pm), 34.2% of participants selected this option, the second most popular time was early evening (5-7pm) with 21.1% choosing this time. 91.0% of participants said that they would prefer to attend an adult only session. 42.0% of female participants and 8.0% of male participants said they would prefer to attend a		**Post-programme questionnaire:** 57% of participants agreed that if the pool was too cold then it could stop them from going swimming **Observational data:** **Theme: Enablers, Subtheme: Access to swimming** *We spoke about how she could catch the train to the Stour centre, she is not local and hadn't realised that this would be the easiest option.*	**Complimentary** Study one had asked about preferences to swimming, including session times, and adult or male or female sessions. Pools which are warmer may be worth signposting along with adult sessions as in study four 57% of participants reported that water temperature could be a barrier to swimming. Study four had a greater proportion of females to males, the participants in study four did not discuss whether they would have preferred a session for just females.

	swimming session with just female or just male swimmers. 39.0% of female participants said they would prefer a session where you were allowed to wear a t-shirt compared to 21.4% of male participants.			**COM-B; Psychological capability** **BCW Intervention function Enablement and education**
Developing a peer support group with others in the class, using social media such as WhatsApp or Facebook (100%)	**Enabler:** 13.5% agreed that they would like to make new friends through swimming; **COM-B Social opportunity**	**Subtheme: My swimming community; COM-B Social opportunity** *'I thought I was happier swimming on my own just because it is easiest to do, jump in and nip down, no planning. But I have really enjoyed swimming with others and the group that we have formed now is just such a lovely combination of people, it is really nice to sit and chat afterwards.' (S10 Outdoor swimmer)*	**Post-programme questionnaire:** 57% of participants agreed that going with a friend or family member would help them continue to swim on a regular basis **Theme: Delivery of programme, Subtheme: Peer support** *'I spend more time interacting with fellow swimmers, time for a chat; I always go with one of the other ladies from the class (S19)'* **Observational data:** **Theme: Delivery of programme, Subtheme: Peer support** *Both (S15) and (S11) have encouraged each other with their swimming, and both realise the benefits to help*	**Divergence** Most of the participants in study one did not agree that they would like to make new friends through swimming, whereas the findings from study two, three and four suggested that this could be a strategy to enable swimming. In study four some of the participants kept in touch and continued to swim together on completion of the programme. In study two a swimming community supported the swimmer and improved safety for outdoor swimmers. **COM-B Social opportunity** **BCW Intervention function Enablement and modelling**

			alleviate their back problems. They are both confident and safe swimmers now. The group are very supportive of each other and that has really helped. Everyone was impressed with (S11)'s front crawl today and she really does look like a swimmer. During the last session (S10), (S8) and (S9) exchanged numbers to support each other.	
Time to reflect on other benefits of swimming, beyond their back pain, such as improvements in fitness, general health, wellbeing, mood, general muscle strength and flexibility, and being better able to manage a healthy weight. Use these benefits as an additional motivational tool (93.33%)	**Enablers:** Participants agreed that the following factors could enable them to swim on a regular basis; 77.8% improvement in strength and flexibility, 75.3% health weight, 72.8% fitness and general health, 70.4% mood and wellbeing. **COM-B Reflective motivation**	**Subtheme: Swimming improves my physical and mental health and functional benefits gained through swimming; COM-B Automatic and reflective motivation** *'Keeping the weight off but also keeping my mobility in my back because I know I do seize up if I don't go.' (S3 Pool swimmer)*	**Post-programme questionnaire:** Participants agreed that the following factors could enable them to swim on a regular basis; 57.1% healthy weight, 71.4% improvement in strength and flexibility, 64.3% mood and wellbeing, 71.4% health and fitness. **Theme: Therapeutic effects, Subthemes: Enjoyment and Confidence** *'I really enjoyed my sessions and feel that I have become more confident in the water (S11)'.* *'I'm very grateful for the confidence it's given me to*	**Convergence** The findings from study one, two and four suggested that considering the wider benefits of swimming could enable regular swimming. **COM-B Reflective motivation** **BCW Intervention function Education and persuasion**

			get back in the water as prior to my back injury I was quite active to what I am now (S17)' **Observational data:** **Theme: Therapeutic effects; Subthemes: Mental health and wellbeing, sleep, and achievement** *S12 reported 2 positive effects, she is feeling more relaxed, her husband is unwell and waiting for treatment, she is also sleeping better.* *S14 spoke about how the class had made her leave the house and catch a train, her adult children were proud of her, and she had started to consider local pools she could go to.*	
Encouragement and positive feedback from person leading the class, highlighting improvements since swimming. Time to reflect on benefits for back pain and general health (93.33%)	**Enablers:** Participants agreed that the following factors could enable them to swim on a regular basis; 77.8% improvement in strength and flexibility, 75.3% health weight, 72.8% fitness and	**Subtheme: My swimming community; COM-B Social opportunity** *'Motivation, if it wasn't for that person or it wasn't for that person to say, 'come on, you can do it, if I can do it, I*	**Post-programme questionnaire:** Participants agreed that the following factors could enable them to swim on a regular basis; 57.1% healthy weight, 71.4% improvement in strength and flexibility,	**Convergence** The findings from study one, two and four suggested that considering the wider benefits of swimming could enable regular swimming. Almost two thirds of people in

	general health, 70.4% mood and wellbeing. **COM-B Reflective motivation** **Enablers:** 61.7% of participants would be more likely to go swimming if their health professional advised them. **COM-B Reflective motivation and social opportunity**	*know that you can do it', then we wouldn't have done it!' (S9 Outdoor swimmer)*	64.3% mood and wellbeing, 71.4% health and fitness. 28.6% of participants would be more likely to go swimming if their health professional advised them. **Theme: Therapeutic effects, Subthemes: Enjoyment and Confidence** *'The swimming class helped me gain my confidence and I did not panic too much. Thank you. (S9)'* **Observational data:** **Theme: Therapeutic effects, Subthemes: Achievement** *S1 has made very good progress and should feel proud.*	study two said that they would be more likely to swim if a health professional had advised them compared to less than a third in study four. This could be because they had been through the programme and had already been advised. The findings from study two suggest that swimming communities could help support the swimmers on completion of the programme. **COM-B Reflective motivation** **BCW Intervention function Education and persuasion**
Signposting to sessions for only adults and for just women or just men (86.67%)	**Preferences** 91.0% of participants said that they would prefer to attend an adult only session. 42.0% of female participants and 8.0% of male participants said they would prefer to attend a swimming session with just female or just male swimmers.	**Subtheme: My swimming community; COM-B Social opportunity** *'Wednesday at Masters.' (S3 Pool swimmer)*	**Post-programme questionnaire:** 31% of participants agreed that if they felt uncomfortable wearing a swimming costume or trunks then it would stop them using swimming as a form of exercise. **Observational data:**	**Convergence** There was a strong preference in study one for adult only swimming sessions. Study four was carried out in a small pool with no general public. It was probably not appropriate to run the sessions at the same time a children's sessions. In study

			Specific sessions were not discussed during the sessions	two participants had discussed adult only swimming communities they were part of and enabled them to swim regularly and provide support. **COM-B Social opportunity** **BCW Intervention function** **Education and enablement**
Offering a session whereby a partner, family member or friend can join them in the water (80%)	**Enabler:** 71.1% agreed that they enjoyed swimming with friends / family, and this would encourage them to swim; **COM-B Automatic motivation and social opportunity** **Enabler:** 66.7% of participants already take their children, a relative or friend swimming	**Subtheme: My swimming community; COM-B Social opportunity** *'I take my daughter swimming at the weekend.' (S3 Pool swimmer)*	**Post-programme questionnaire:** 57% of participants agreed that going with a friend or family member would help them continue to swim on a regular basis **Observational data:** *We did not offer this session during the programme*	**Convergence** This was not offered in study four but the data from the study one and two suggests it could be considered in future delivery of the programme. **COM-B Social opportunity** **BCW Intervention function** **Enablement**
Setting goals, being comfortable prioritising self so able to swim regularly and making a written action plan before the last session (80%)	**Barrier:** 76.7% agreed that they lacked motivation to go swimming; **COM-B Reflective motivation** **Enabler:** 82.0% agreed that setting goals and making an action plan could help them go swimming more regularly; **COM-B Reflective**	**Subtheme: My goals and motivation; COM-B Reflective and automatic motivation** *'My aim, I can only do a length in 35 seconds, but I want to be quicker.' (S8 Pool swimmer)*	**Post-programme questionnaire:** 57% of participants agreed that if they set goals and made an action plan it would help them continue to swim on a regular basis 46% of participants agreed that if they lacked motivation to go swimming then it would	**Convergence** The findings from study one, two and four suggest that setting goals and making an action plan could enable regular swimming. **COM-B Reflective motivation**

	motivation and physical opportunity		stop them using swimming as a form of exercise. **Theme: Enablers: Subtheme: Motivation and goal setting** *'My aim is to go at least once per week. At the moment this is what I am doing. (S11)'.* *'I have never been a strong swimmer but am fairly confident in the water and felt very motivated to do this and try and help myself (S10)'.* **Observational data** **Theme: Enablers: Subtheme: Motivation and goal setting** *She announced that she used to swim 40 lengths before her back problem, so she is quietly determined to get back to that.*	**BCW Intervention function Education, training, and enablement**
Further drop-in sessions at pool (73.33%)	**Barrier:** 76.7% agreed that they lacked motivation to go swimming; **COM-B Reflective motivation**		**Post-programme questionnaire:** 60% of participants agreed that 6 sessions was sufficient and 20% would have like more sessions 46.2% agreed that lack of motivation could be a barrier to swimming	**Complimentary** The findings from study one suggested that lack of motivation could impact up to three quarters of people with LBP. The findings from study four suggest that those who struggle with motivation and the less able

			Theme: Enablers, Subtheme: Support after programme *Enjoying class. Will book more lessons with local teacher at pool, whom she knows, to gain more confidence and control in the water (S13)* **Observational data:** **Theme: Enablers, Subtheme: Support after programme** *Enjoying class. Will book more lessons with local teacher at pool, whom she knows, to gain more confidence and control in the water (S13)*	swimmers may benefit from further sessions either within in the programme or with other providers. **COM-B Physical opportunity** **BCW Intervention function Enablement, training, and environmental restructuring**

Programme objectives **COM-B: Physical and psychological capability, physical and social opportunity, and automatic and reflective motivation** **BCW Intervention function: Enablement, education, modelling, environmental restructuring, persuasion, and training**				
Study three **Mixed methods**	**Study one** **QUAN**	**Study two** **QUAL**	**Study four** **Multi-methods**	**Meta inferences and interpretations**
Objective 1: To improve confidence swimming with CLBP, developing swimming ability through teaching the aquatic skills and adapting swimming strokes for CLBP				
Programme sections: Delivery of programme; **COM-B Physical and psychological capability;**	**Ability:** 52.4% were able to swim 50 m or more 9.8% has had swimming lessons as an adult	**Theme: Learning to swim with back pain** **Subtheme: My swimming journey; COM-B Physical and psychological capability,**	**Swimming ability:** Prior to starting the programme 31% of participants were able to swim a length of the pool and on completion of the	**Convergence** The findings from all four-studies support including this programme objective. There were no new insights

BCW Education, enablement, and training Teaching and coaching approaches; **COM-B Physical and psychological capability physical and social opportunity; BCW Education, enablement, and training** Core aquatic skills; **Physical and psychological capability; BCW Education Training** Swimming strokes; **Physical and psychological capability; BCW Education Training** 93.33% agreement to subgroup for LBP and to take a kinaesthetic / problem solving approach when delivering the programme. 93.33% agreement to include problem solving trialling different positions, learning how to make stroke more comfortable for back in the teaching of the three swimming strokes	**Barrier:** 18.3% agreed that they have a fear of water; **COM-B Psychological capability and automatic motivation** **Barrier:** 31.3% agreed that they were worried that swimming would make their LBP worse; **COM-B Psychological capability** **Barrier:** 21.0% agree that they found that their LBP was worse after swimming; **COM-B Physical capability** **Barrier:** 14.8% agreed that they found that their LBP was worse while swimming; **COM-B Physical capability** **Enabler:** 38.3% agreed that experiencing less LBP in the pool would encourage them to swim; **COM-B Physical capability** **Enabler:** 23.5% agreed finding that swimming eased their LBP would	**Physical and social opportunity** *'When I was with my physio with the NHS they told me that swimming might be good for my back not only that I can do it but it might be good for my back, so I was actually recommended it.' (S11 Pool swimmer)* **Subtheme: How my back feels when I swim** *'So, for my back the one that I am consciously trying to do is front crawl but only using my arms, which I do not know whether it is right or wrong, but it means that I am just lengthening in the water all the time.' (S1 outdoor swimmer)* **Subtheme: How I swim with back pain; COM-B Physical and psychological capability** *'With the initial injury it actually made it a bit worse. I found that the position that*	programme 75% were able to swim that distance. See Table 7.7 for development of swimming ability and skills during the study period **Adapting swimming:** Under the theme, *delivery of the programme*, subtheme, *problem solving and adapting swimming*, various strategies were mentioned in how problem solving was used to adapt swimming for CLBP **Confidence:** Under the theme, *therapeutic effects,* subtheme, *confidence*, the participants spoke about gaining or regaining confidence through the swimming programme	with regards to the COM-B model and BCW analysis. The number of sessions may need to be increased for more nervous swimmers; in the current form it enabled the development of swimming ability for the majority of participants. Further research would be required to better understand and document these adaptations and to develop a better understanding of how to facilitate swimming confidence in this population.

93.33% agreement for learning to adapt swimming for nerve damage Agreement to include of all core aquatic and teaching of three swimming strokes: front crawl, backstroke, and breaststroke.	encourage them to swim; **COM-B Physical capability**	*I was in in the water when swimming on my front wasn't good. The only way that I could swim comfortably was on my back.' (S14 Pool swimmer)* **Subtheme: My barriers to swimming and how I overcome them; COM-B Physical and psychological capability** *If anything, I have improved, rather than steer away, the backstroke is just a confidence thing, but I could do it.' (S8 Pool swimmer)* *'I had a couple of lessons with a teacher, near Bodium in the river, and she was teaching me a better breaststroke. So really going down into the water and up and she was saying if you are swimming above the water the whole time it is really bad for you, it will strain your back so yes, I would say that I am quite careful about really following, I have her words in my mind that I really focus on*		

		my stroke.' (S10 Outdoor swimmer) **Theme: How swimming looks for me; COM-B Physical and psychological capability Physical and social opportunity** *'At the moment I go 4 or 5 mornings, and it is about 40 minutes and Wednesday evening for an hour.' (S3 Pool swimmer)*		
Objective 2: To integrate pain management skills with swimming				
Programme sections: **Programme set up** Pre-programme information; **COM-B Physical and psychological capability; reflective motivation; BCW Enablement** Delivery of programme; **COM-B Physical and psychological capability; BCW Education Enablement, Training** Session brief; **COM-B Psychological capability and reflective motivation; BCW education**	**Enabler:** 61.7% agreed that setting goals and making an action plan could help them go swimming more regularly; **COM-B Reflective motivation and physical opportunity**	**Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** *'I do 400m just relaxed, no stress freestyle just stretching out slowly and then I will do another 400 and I will throw in a breaststroke length. So, every 4th length will be breaststroke, just so I can start stretching. Long stretching breaststroke just to start, opening up, just stretching all the bits that*	There were a wide range of pain management skills, the theme, *enablers*, included *goal setting, prioritising, building a support team, and developing exercise routine*	**Complimentary** The findings from all four-studies support including this programme objective. New insights with regards to the COM-B and BCW analysis with the addition of reflective and automatic motivation and the following interventions: modelling and persuasion Further research would be required to better understand which pain management skills could be of value when delivering

Session debrief; **COM-B Physical and psychological capability; reflective motivation; BCW Education Persuasion Training** Warm up; **COM-B Physical capability and psychological capability; BCW Education and training** Cool down; **COM-B Physical and psychological capability; social opportunity; automatic motivation; BCW Education Training** Strategies to enable people with CLBP become regular swimmers; **Physical and psychological capability; physical and social opportunity; reflective motivation; BCW Education Enablement Environmental restructuring Modelling Persuasion Training** **Pacing and regular exercise:** 100% agreement on frequency of sessions and 93.33% on the length of session **Set back plan:** 100% agreement to teach how to cope with a painful episode		*need to be stretched.' (S2 Pool swimmer)* **Subtheme: My training regime; COM-B Physical and psychological capability, Physical and social opportunity** *'I do, do a general one, it is not particularly organised one, but it is just to loosen off because I tend to swim first thing in the morning. I do find when I get up my back has obviously been in one position and it just needs a bit of loosening off before I get in, because otherwise I find the first 200m quite uncomfortable so I will do some general loosening off before I get in but nothing specific.' (S14 Pool swimmer)* **Subtheme: My feelings about swimming; COM-B Automatic motivation** *'I was saying to someone the other day, you know you are literally having to stay alive aren't you and focusing on just that process of staying*		swimming as a rehabilitation modality

when swimming in core aquatic skills section **Relaxation:** 86.67% agreement to include breathing exercises and mindful breathing and 87.5% agreement to include an awareness exercise **Peer and professional support:** 100% agreement for developing a peer support group with others in the class, using social media such as WhatsApp or Facebook and 73.33% agreement for further drop-in sessions at pool **Goal setting and prioritisation:** 80% agreement for setting goals, being comfortable prioritising self so able to swim regularly and making a written action plan before the last session		*afloat. I think with my back pain it's always in the back of my mind even if there isn't any, I am pre-empting almost, the more I do it the less I have been kind of worrying about it.' (S10 outdoor swimmer)*		
Objective 3: To recognise and address barriers to swimming and enable people with CLBP become regular swimmers				
Programme sections: Pre-programme information; **COM-B Physical and**	All barriers, enablers, and preference data	**Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability**	**Barriers**: After the programme the participants were asked about barriers which might stop them swimming, these were the	**Complimentary** The findings from all four-studies support including this programme objective. New insights with regards

psychological capability; reflective motivation; BCW Enablement Session debrief**; COM-B Physical and psychological capability; reflective motivation; BCW Education Persuasion Training** Strategies to enable people with CLBP to become regular swimmers; **COM-B Physical and psychological capability; physical and social opportunity; reflective motivation; BCW Education Enablement Environmental restructuring Modelling Persuasion Training**		*If anything, I have improved, rather than steer away, the backstroke is just a confidence thing, but I could do it.' (S8 Pool swimmer)* **Subtheme: My barriers and how I overcome them; COM-B Physical and psychological capability** *'I had a couple of lessons with a teacher, near Bodium in the river, and she was teaching me a better breaststroke. So really going down into the water and up and she was saying if you are swimming above the water the whole time it is really bad for you, it will strain your back so yes, I would say that I am quite careful about really following, I have her words in my mind that I really focus on my stroke.' (S10 Outdoor swimmer)* **Subtheme: My swimming community; COM-B Social opportunity** *'I thought I was happier swimming on my own just*	same barriers included in the survey in study 1. The top barriers were cost (67%, n=10), time (60%, n=9), pool temperature (53%, n=8), swimming ability (40%, n=6), pain after swimming (40%, n=6), and lack of motivation (40%, n=6). The theme, *barriers* identified ten barriers: *time, cost, caring responsibilities and work, co-morbidities, pool temperature, lack of confidence, mental health, loss of sensation, and short-term illness* **Regular swimmers**: Prior to the swimming programme only 6% (n=1) of the participants had swum regularly and most hadn't swum for many years. After the programme all but one of the participants intended to go swimming, that participant was not intending on swimming due to a chlorine allergy which affected his nose. The 6-month follow up	to the COM-B and BCW analysis with the addition of physical and psychological capability and physical and social opportunity from the COM-B model and the following interventions, environmental restructuring, modelling, persuasion, and training. The thematic analysis in study four identified additional barriers not asked in the questionnaire. Further research on barriers and enablers is required to better understand how barriers can be addressed.

		because it is easiest to do, jump in and nip down, no planning. But I have really enjoyed swimming with others and the group that we have formed now is just such a lovely combination of people, it is really nice to sit and chat afterwards.' (S10 Outdoor swimmer) **Subtheme: My swimming community; COM-B Social opportunity** *'Motivation, if it wasn't for that person or it wasn't for that person to say, 'come on, you can do it, if I can do it, I know that you can do it', then we wouldn't have done it!' (S9 Outdoor swimmer)*	questionnaire found that 60% (n=9) had continued swimming on a regularly basis.	
Objective 4: To use swimming to improve function, physical activity, quality of life, physical and mental health, and weight management				
Programme sections: Swimming strokes; **COM-B Physical and psychological capability; BCW education and training** Strategies to enable people with CLBP to become regular swimmers: **COM-B Physical and psychological capability; physical and social**	**Enablers:** 77.8% of participants would like to use swimming to improve their muscle strength and flexibility, 75.3% to help them maintain a healthy weight or lose weight, 72.8% to improve their fitness and general health and 70.4% to improve their	**Subtheme: Swimming improves my physical and mental health and functional benefits gained through swimming; COM-B Automatic and reflective motivation** *'Keeping the weight off but also keeping my mobility in*	**Physical activity:** 60% of participants were still swimming 6-months after completing the programme. **Function and quality of life:** See Table 7.8 for full results from PSEQ, ODI and EQ-5D-3L. The data was underpowered so was only	**Complimentary** The findings from all four-studies support including this programme objective. New insights with regards to the COM-B and BCW analysis with the addition of Physical and psychological capability; physical and social opportunity

opportunity; reflective motivation: BCW Education Enablement Environmental restructuring Modelling Persuasion Training 93.33% agreement on spending Time to reflect on other benefits of swimming, beyond their back pain, such as improvements in fitness, general health, wellbeing, mood, general muscle strength and flexibility, and being better able to manage a healthy weight. Use these benefits as an additional motivational tool	mood and wellbeing; **COM-B Reflective motivation**	*my back because I know I do seize up if I don't go.' (S3 Pool swimmer)*	presented with descriptive statistics, the data shows small improvement in disability and quality of life within the groups. **Physical health:** The median health status score for the EQ-5D-3L improved by 10 points in the swimming arm and 15 points in the physiotherapy arm **Mental health:** There was no change in the level 1 scores for mental health The theme *therapeutic effects*, subtheme *mental health, and wellbeing*, discussed improvement in **mental and health and wellbeing** during the programme. The theme, *barriers*, subtheme *mental health* discussed how anxiety can be a barrier to swimming. **Weight management:** The programme was accessible to people with a wide range of BMIs; ranging from 17.3 to 58.7, median 28.5. 4 participants were obese, and 2 participants were severely	components from the COM-B model and the following interventions, enablement, environmental restructuring, modelling, and persuasion. Further research would be required to better understand the value to people with CLBP of being more physically active with swimming.

			obese, 2 participants were underweight. No data was collected regarding change in BMI.	